▪ BIAS IN PEER REVIEW ▪ CUTTING THE WASTE IN TRASH ▪

▪ REGULATION VS. BIOTECH ▪

Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

NOVEMBER/DECEMBER 1987

$3.00

DOES THE NEXT OIL CRISIS HAVE TO BE SO BAD?

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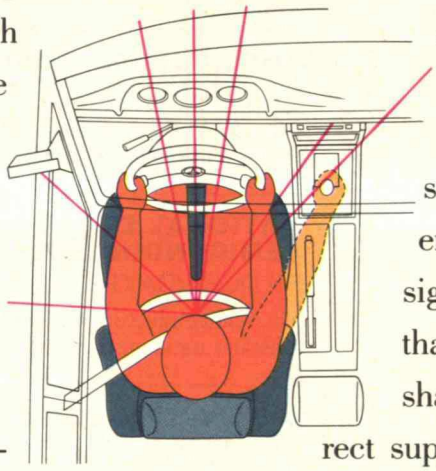
technology
review
Published by MIT

THE MERCEDES-BENZ 190 CLASS: THE DELIGHTFUL PARADOX OF BEING IN A RUSH AND WANTING IT NEVER TO END.

You have no reason to hurry, other than to see how a sedan built for triple-digit Autobahn velocities, and equipped with what Britain's *Car* magazine terms "the most sophisticated steel suspension ever put into volume production," might elevate the experience of driving.



So you lean on the throttle a bit. The speedometer needle darts upward. The scenery begins to blur. But all other familiar sensations of speed have been transformed.

Engine and wind noise are reduced to what one automotive writer described as "a hushed *whoosh*." In place of juddering tires comes an unflustered negotiation of the road's flaws. The car does not lurch through turns but shifts direction crisply, smoothly. Missing are the chassis squeaks that you expect as a matter of course. That anxious sense of being on the edge has given way to a calm, purposeful sense of control.

The effect is liberating; you do not grapple with a 190 Class sedan but confidently direct it. Because Mercedes-Benz engineers grappled in advance with thousands of design details, aiming to achieve consummate driving efficiency – a state wherein automobile and driver interact to maximum effect, with a minimum of wasted energy and motion.

The feelings of pleasure and deep satisfaction that ensue are intensified by other signs of scrupulousness. By seats that are not styled but built and shaped for biomechanically correct support. By controls that provide an object lesson in ergonomic intelligence. By craftsmanship that led *Car and Driver* to ask, "How is it that Benzes fit together better than anything else in the world?" By the reassuring presence of the Mercedes-Benz Supplemental Restraint System (SRS), with its driver's-side air bag and knee bolster and front seat belt emergency tensioning retractors, primed to deploy within milliseconds of a major frontal impact.

The only perplexity is how, at this quickened pace, to make the trip last just a little longer.

Engineered like no other car in the world

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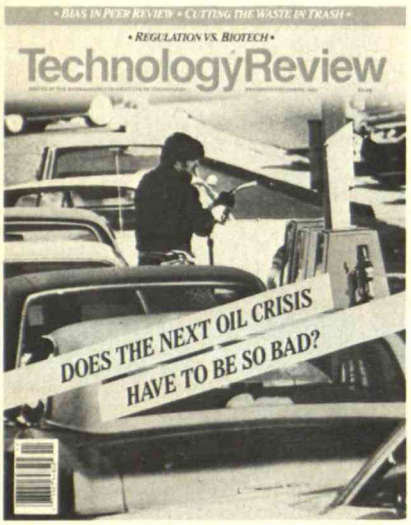

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COVER
Photograph by Dennis Brack/ Black Star
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"Testing one, two, three."

This is an experimental computer system that turns words that are spoken into words that are seen.

It's a speech recognition system being developed by IBM research, and it's the most innovative one of its kind.

In fact, the device you see here performs up to 30 million calculations to decipher a single word. It understands over 20,000 words. It adjusts to different accents. It even distinguishes between words that sound alike

but have different meanings, such as two, to and too. So you can dash off a letter, write a report, even try your hand at the great American novel–by speaking into a microphone.

Right now this technology is still experimental. But someday, it could make using a computer as easy as one, two, three. And you can't say enough about innovation like that.

This speech recognition system is a research project and can not be purchased. For more information write: IBM Communications, T.J. Watson Research Ctr., P.O. Box 218, Yorktown Hgts., NY 10598.

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FIRST LINE

FROM THE EDITOR

Regulation by Referendum?

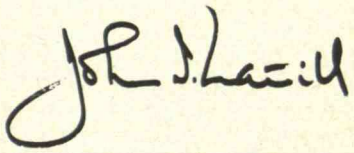
A *Technology Review* reader who edits several management newsletters has shared with us a humorous essay proposing that technology is "a detour on our road to utopia." When he enjoyed "Little Orphan Annie" and "The Green Hornet," our author recalls, radios had two knobs—on-off-volume and tuning. Now they have dozens, and finding the radio program one wants may require access to a complex instruction book written in "pidgin Japanese." The automobile that required for starting only two simple acts—set choke and push button—has been replaced by one that will not start until it has given its user a long recitation about its state of health.

We're all familiar with such tongue-in-cheek complaints about modern technology, and we all recognize that they are humorous precisely because they overstate the frustrations while ignoring the benefits of the remarkable devices on which our efficient but complex society has come to depend. Quite clearly, for example, our author's contribution was not the product of the simple Remington portable that he remembers with affection.

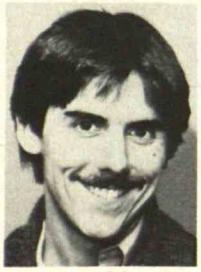
But not all of today's opposition to technology is quite so good-natured. Laser-based weapons that are part of the Strategic Defense Initiative, chemicals that become toxic pollutants when they escape from their intended applications, and nuclear power are examples of technologies that have attracted substantial opposition. Indeed, as David D. Schmidt, executive director of the Initiative Resource Center, pointed out in our Trends column in August/September (*page 15*), concerned voters have recently taken some of these questions out of the hands of policymakers and turned them into referenda in state and local elections.

Does all this suggest an anti-technology groundswell in the United States? Perhaps not. According to a survey conducted by Louis Harris and Associates for the Office of Technology Assessment a year ago, a very large proportion of Americans (80 percent) expect future benefits from science and technology, and most (71 percent) accept that risks will be inherent in those technological innovations. Furthermore, many Americans consider themselves well informed about the issues posed by technology: almost half (47 percent) of those queried said they were "very interested, very concerned, or very knowledgeable" about science and technology.

The OTA survey should reassure those among our readers who are troubled by the trend that substitutes popular judgments for expert policymaking on technology. It also encourages editors, like those at the *Review*, committed to broadening the understanding of technology among thoughtful Americans.



Welcome to Howard



The Editors announce with regret the departure from our masthead of Alison Bass, senior editor, and with pride the arrival of Robert Howard to fill the resulting empty desk.

Howard has been working as a journalist since 1978, frequently writing about labor-management issues and technological change. Even before that, workplace issues were a focus of his interest; his Amherst College honors thesis (1976) was an oral history of a small, family-owned factory in Detroit. Several fellowships and grants, including an appointment as visiting scholar in the M.I.T. Program in Science, Technology and Society in 1982, led to his book, *Brave New Workplace* (Viking, 1985). That same year he was the author of "Utopia: Where Workers Craft New Technology" in *Technology Review* (*April 1985, page 42*). His work has also appeared in *The New Republic, The Nation, Commonweal, Mother Jones,* and *Working Papers* (of which he was an editor from 1980 to 1983).

Former senior editor Alison Bass made significant contributions to our pages, responsible for the appearance here of important articles on subjects ranging from artificial intelligence to environmental pollution and computers in education.

PHOTO: BILL RAVANESI

Biowars, Software Reliability

BIOLOGICAL WARFARE

Much of what Seth Shulman says in "Biological Research and Military Funding" (*April 1987, page 13*) is at best misleading and at worst wrong. For example, he states that for fiscal-year 1987 the Defense Department has requested $73.2 million for research on biological weapons. But the department has received only $58.7 million for medical biological R&D, which includes $35.2 million for biotechnology projects.

I also object to Shulman's assertion that unclassified evidence of the Soviet Union's research on biological warfare is "inconclusive." Inconclusive to whom? I recommend Shulman reexamine the unclassified evidence regarding the 1979 Sverdlovsk incident, which cost the lives of several hundred people who contracted pulmonary anthrax.

Regarding the claim that the Defense Department funds research on the dengue-2 virus, which Shulman says is "deadly," and rift valley fever, which he says is "lethal"—yes, that research is ongoing. But those diseases are rarely fatal. They do severely debilitate people. Military research focuses on developing vaccines against such illnesses, not on developing biological weapons. The latter is prohibited by a national security decision memorandum dated November 25, 1969.

DONALD H. HOLT
Fort Benning, Ga.

The author responds:

Only the amount requested for research on biological weapons in fiscal-year 1987, not that actually budgeted, was available at press time. My observation that funds for biological warfare have quadrupled during the Reagan administration holds true for fiscal-years 1986 and 1987.

The 1979 Sverdlovsk incident is a prime example of contested evidence of a Soviet biological-weapons campaign, according to several authorities I interviewed—including some with access to classified information. Moreover, the Soviet delegation offered to discuss the incident in detail at the recent conference in Geneva, but the United States did not accept.

It is true that some of the diseases being investigated aren't always fatal. But I wanted to emphasize the claim by many observers that all biological-weapons research—whether oriented toward debilitating diseases or fatal ones, toward vaccines or not—has an offensive potential and thereby threatens to further escalate a biological arms race.

FAULTY SOFTWARE

Ronald L. Enfield's "The Limits of Software Reliability" (*April 1987, page 36*) really hit home. As a software engineer for a major defense contractor, I am well aware that software design specifications and testing procedures are all too often shrouded in secrecy and red tape. Security classifications are distributed in such a way that junior-level programmers who actually do the bulk of the coding know the least about a system's overall performance goals. Furthermore, government representatives who oversee engineers' work are frequently preoccupied with documentation standards rather than functionality.

M.R.B.
Chestnut Hill, Mass.

The limits of software reliability that Mr. Enfield describes must be recognized in community right-to-know programs across the country. This March the National Response Team issued its *Hazardous Materials Emergency Planning Guide* without calling for software-reliability verification.

H. THEODORE WERNER
Tempe, Ariz.

I take issue with Ronald Enfield's point that "we should not develop large software systems for which the consequences of failure are unbearable." He is surely aware that many such programs are in daily use. The pilots of the space shuttle cannot influence the craft except through digital computers, software, and other electrical systems that are unequivocally required for flight. The Concorde, in daily service for more than 15 years, can fly only with the aid of analog computers comparable to 4,000-word digital computers and associated software. Many military aircraft can fly only with analog or digital computers, and all land-based and ship-

Continued on page 68

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The aurora is one of many phenomena that the emerging field of plasma space physics studies.

Lab for the Universe

Since 1983 an international trio of space agencies has been planning an ambitious project that could expand the understanding of geospace—the region of outer space immediately surrounding the earth. With it could come insight into exotic phenomena such as "space weather"—including magnetic storms that can disable communications, weather, and military satellites.

Dubbed the International Solar-Terrestrial Physics (ISTP) Program, this four-satellite venture involves NASA, the European Space Agency (ESA), and Japan's Institute of Space and Astronautical Science. ISTP planners hope to launch the satellites in the mid-1990s.

Anxiously awaiting the launch are researchers in space-plasma physics, a discipline preoccupied with geospace. This satellite-dependent field properly began with the launch of *Explorer I* in January 1958. It blossomed in the 1960s when dozens of satellites mapped geospace, and by the early 1970s the data had revealed a complex, interactive environment. It also revealed that the aurora, the luminous light curtain in the night sky, is an image of geospace turbulence.

The primary components of geospace are solar wind, the magnetosphere, and the ionosphere. Solar wind is a supersonic flow of electrically charged gas, called a plasma, that the sun continuously exudes. The magnetosphere is a comet-shaped bubble around the earth formed by the impact of the solar wind upon the terrestrial magnetic field. The ionosphere is the frontier between earth's electrically neutral atmosphere and the charged atmosphere of space.

Solar wind creates an aurora when it blows across interconnected solar and terrestrial magnetic lines high above each pole. Charged particles leak into the magnetosphere, engorging it like air into an accordion. Eventually the magnetosphere can hold no more and the charged particles spiral down along the earth's magnetic field, colliding with uncharged particles in the upper atmosphere. The result is the glow of the aurora. "The aurora is like a live television broadcast of what's going on in the magnetosphere," says Nelson Maynard, chief of the Space Plasma and Fields Branch at the U.S. Air Force Geophysical Laboratory.

Maynard calls such changes in space plasma space weather. Often, he says, a "stormy" magnetosphere affects earth. "Solar wind variations cause turbulence in the ionosphere, which can disrupt communications and radar." It can also trigger relays in power lines, creating power outages. In addition, satellites in low orbits have failed during magnetic storms.

Thus, a long-range goal of space-plasma physics, says Maynard, is to predict space weather. Tim Eastman, branch chief for magnetospheric physics at NASA's Space Plasma Physics Division, claims that a better understanding of space weather is essential to future space endeavors. "If you want to put up a space station, you have to pay attention to the interaction of plasma and the station," he says.

Other researchers point out that plasma environments resembling geospace exist elsewhere in the universe. "We can use the earth as a laboratory for understanding phenomena far away in the universe," says Tom Chang, director of M.I.T.'s Center for Theoretical Geoplasma Research. Data obtained from earth satellite missions, for example, could help explain magnetospheres around pulsars and radio galaxies.

Dwindling Satellites

Space-plasma physicists say they need ISTP's four large satellites, which will simultaneously cover the four corners, as it were, of the globe. This would be the first major experiment in the field in more than a decade. While NASA launched 14 explorer-class space-plasma satellites in the 1970s, it has orbited just three since 1981.

"Satellites are our major vehicle," says Roger Arnoldy, associate director of the Institute of Earth, Oceans, and Space at the University of New Hampshire. While less expensive or earthbound instruments may supplement or verify information gathered in space, some phenomena, such as the composition of solar wind, can't be measured from the ground.

Many researchers are frustrated by the dwindling number of satellites devoted to space-plasma research. "Space physics is in a sad state," says Mike Temerin, an assistant research physicist with the Space Science Laboratory at the University of California at Berkeley. He notes that NASA proposed the ISTP program in 1977, but the project was so expensive that it precluded most other NASA-sponsored space-plasma experiments. NASA then cut the project in half: it convinced Japan to take one satellite and ESA another; and pushed back the launch date for the remaining two satellites.

PHOTO: GEOPHYSICAL INSTITUTE, UNIVERSITY OF ALASKA

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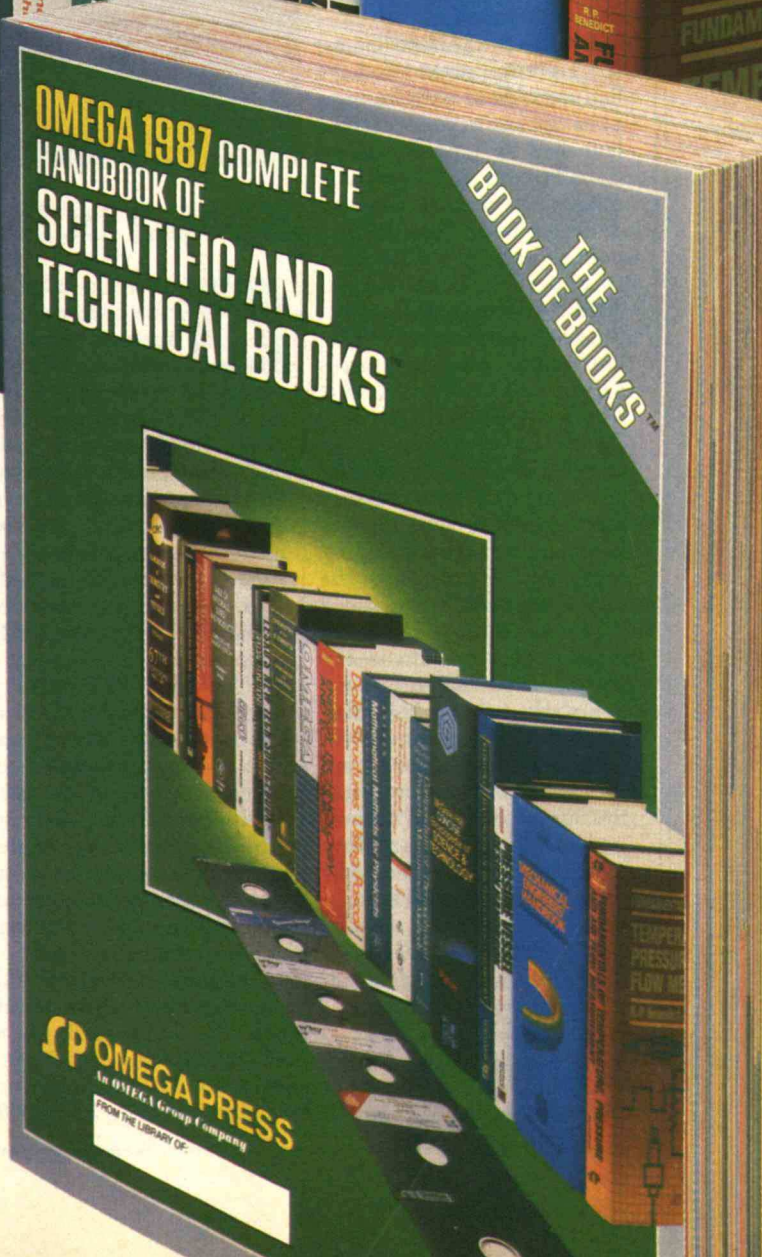

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Even the modified project is in jeopardy. When various projects—the shuttle, space exploration, and space-plasma experiments—had to compete for limited congressional appropriations, the shuttle won. But if NASA can overcome the shuttle disaster and Congress approves the funds for ISTP, this international venture could be invaluable. Says Arnoldy, "ISTP is extremely important because it will attempt to get crucial sets of measurements all at the same time."

Despite NASA's problems, space-plasma physicists have had a trickle of data from recent geospace satellites launched by Japan, Sweden, Canada, and ESA. Sweden's *Viking* satellite, launched in 1986, circles the earth from pole to pole measuring electrical particles in the aurora. A less ambitious three-satellite venture between the U.S., Germany, and Britain—dubbed AMPTE (*Active Magnetospheric Particle Tracer Explorers*)—went up in 1984. Researchers also collect some data from military meteorological satellites and from inexpensive sounding rockets that briefly pierce the magnetosphere. They gained data, too, from a 1983 space shuttle that measured the plasma surrounding it.

Finally, *Dynamics Explorer I (DE-1)*, launched in 1981, continues to collect important information about the aurora, which it "photographs" by digital remote sensing every 12 minutes. The result, says John Craven, a University of Iowa scientist who works on the *DE-1* project, is "like a movie of the aurora." □

TOM KIELY is a Boston-based freelance writer. His most recent contribution to Trends was "Rushing Drugs to Market."

PHOTO: GUY GURNEY

Speed in the Groove

A common adhesive tape used to apply fake woodgrain to station wagons may soon be applied to airplanes, yachts, and torpedoes. When inscribed with "riblets"—tiny grooves similar to those in records—the tape reduces drag in air and water up to 4 percent. Experts estimate that the tape could save commercial aviation $250 million on its yearly $10 billion fuel bill.

"The tape can be used anywhere you have skin friction, like missiles and interstate gas lines," says riblet inventor Michael Walsh, leader of the Turbulent Drag Reduction Group at NASA's Langley Research Center in Hampton, Va. "Riblets are useful for anything that goes fast and that has some size to it."

Research into triangular surfaces, from which riblets eventually developed, began decades ago. Walsh unearthed long-forgotten studies from the mid-1950s showing that water passing through a triangular pipe encountered little friction. NASA officials believe that such pipes were never mass-produced because they were more expensive and carried less liquid than circular ones.

NASA looked at the concept when the 1970s oil embargo sparked interest in improving fuel efficiency. For wind-tunnel tests, researchers inscribed the riblets directly onto models, but found that the precision needed to do the same on full-size aircraft was too intricate for machines of the day. So the results were simply published in a 1981 technical briefing for commercial industry to follow up. From this, 3M Co. researchers got the idea to inscribe riblets on adhesive tape that the company manufactures for decorating automobiles.

The triangular shape causes what is called laminar flow, which reduces drag approximately 70 percent when an object passes through air or water. Laminar flow is the opposite of turbulence. "Smoke flowing in a smokestack is laminar," Walsh explains, because it moves smoothly parallel to the walls of the stack. "When it comes out you have turbulence" as it scatters in the atmosphere.

When riblets are placed parallel to the flow, they reduce turbulence in an all-important layer of water or air traveling 1/100 of an inch from a surface. Preventing eddies there decreases a chain reaction of turbulence three to four inches from the surface, where it is most destructive.

The 1987 America's Cup yacht race marked the first application of the tape. Sailors attribute *Stars & Stripes'* victory partially to the riblets that covered the hull of the 12-meter yacht. That victory convinced others, and riblet tape is now on most competition yachts.

From Sea to Air

The first attempt to create

The 1987 America's Cup race marked the first use of a new ribbed tape that reduces drag on boats and planes.

laminar flow in air with riblets will occur late this year when Boeing Commercial Airplane Co. applies riblet tape to a 757 jet. Boeing will conduct two flight tests, one with the tape and one without, according to J. Douglas McLean, Boeing aeronautical engineer.

Though NASA officials say there will be future tests, the two Boeing tests are expected to be sufficient because the principle has been proven in wind tunnels. If the riblet-equipped plane realizes the expected 4 percent drag reduction, the savings would be approximately 50,000 gallons of fuel per year on each 757, says McLean.

A second objective of the flight test is to study the tape's resistance to weather, erosion, insects, and the hydraulic fluids that splatter aircraft. "It comes down to a matter of economics when you factor in maintenance, recoating, and cleaning," says Charles Boppe, an aerodynamics specialist at Grumman Corp., which is considering using riblets on military aircraft.

The navy is also studying the maintenance factor. To be effective on seagoing vessels, the tape must be kept free of sea organisms. Barnacles and algae would quickly clog the grooves and prevent laminar flow. "Anything that is left in the water for more than an hour or two gets fouled," notes Michael M. Reischman, fluid dynamics program manager at the Office of Naval Research. Clogged riblets are not a problem on competition yachts, which are removed from the water after each race and meticulously cleaned.

Because of the constant need for maintenance, riblet tape would be more suitable "for something that is only in the water for a short time, like a weapon," says Reischman. The Naval Ocean System Center in San Diego is currently examining riblet tape for torpedoes. Ocean tests of a riblet torpedo could begin in about two years. □

BARRY ROSENBERG is a Washington, D.C.-based freelance writer specializing in science and technology.

Frank Marentic, the inventor of "riblet tape," applies it to a sailboard.

PHOTO: 3M

Academia, Inc.

Although his office will soon move to a building at Washington University in St. Louis, Brian Clevinger doesn't work for the school. He is the "on-campus representative" of a private corporation—the A/W Company. His job is to commercialize technological advances generated by the university's research.

With this venture, Washington University last year became the first university to start its own private marketing arm. A/W Company, of which the university is co-owner, will found private firms to develop and market biomedical and other high-tech products.

While such arrangements could help keep U.S. industry competitive by marketing academia's new technology directly, they stretch the norms of corporate/university relations. According to Tufts University science historian Sheldon Krimsky and others, corporate interests threaten to skew research priorities. Krimsky, who has written extensively on the topic, believes that "when a university has its own for-profit sector, it means that the institution has to manage according to very different rules."

Corporate attention to the campus has increased for several reasons. Rapid advances in computer technology and genetic engineering have illustrated the commercial possibilities of academic research. Also, competition in high-tech fields, most notably from Japan, has severely challenged the U.S. economy, fueling the drive to capitalize on academic research. Finally, a 1981 change in federal law has allowed universities title to government-funded research.

At the same time, leading universities are turning more and more to corporate support as federal funding decreases. According to the U.S. Department of Education, federal funding for university research dropped nearly 50 percent between 1980 and 1985, the last year for which the department kept aggregate totals. This trend is especially worrisome since the government still accounts for 70 percent of university research funds.

"Industrially funded research is our most significant growth area in funding," says Carol Van Akin, director of M.I.T.'s Office of Sponsored Research, where industry funding has risen 20 percent annually since 1976 and now totals about 15 percent of all research dollars.

Research for Sale

To establish A/W Co., Washington University in 1986 formed a limited partnership with the Alafi Capital Company, which is owned primarily by the St. Louis-based multinational company Monsanto. Two years earlier, the parent company had contracted with the university for $62 million worth of biomedical and biotech research. That contract allows Monsanto to review the commercial prospects of all work done in the collaborative biomedical research project, with licensing rights to develop the research into products.

Monsanto now has two ways to commercialize the school's biological research. It can assert its right to it di-

rectly, or A/W Co. can start a company devoted to marketing it. In the latter case—more appropriate for smaller, perhaps riskier ventures—profits would be shared equally with the university.

A/W Co. hopes to initiate roughly one company per year from a pool of up to 30 possibilities, according to Duke Leahey, director of industrial contracts and licensing at Washington University. Just before A/W Co. was officially launched, the university became a partner with Alafi in Field Inversion Technologies, Inc., which will exploit a new technique for the basic genetic-engineering procedure of sequencing DNA in large, complex proteins.

Other corporate relations exist at virtually every major university. Carnegie Mellon's Magnetic Technology Center invites corporations to become associate members. The $750,000 minimum fee buys members, including IBM, Kodak, and Digital, the right to designate three topics for academic research. The companies also gain a seat on the center's advisory board and can send a full-time scientist to work at the center. Other benefits include royalty-free patent rights, software copyrights, and preprints on funded research.

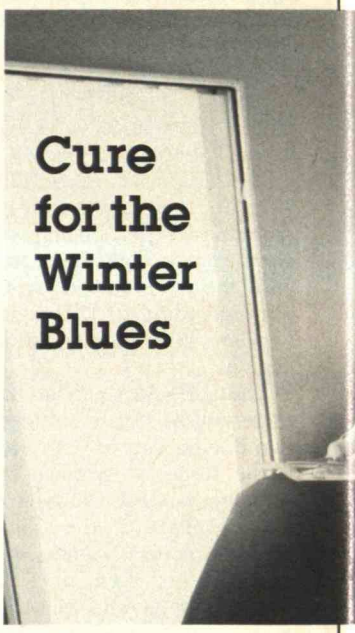
Although it is unusual for corporations to dictate research topics, corporations do discourage certain research. John Longwell, a chemical engineer at M.I.T.'s Energy Lab, thinks pre-grant discussions with potential corporate funders often have such an effect. For example, he says Exxon discourages about 20 percent of the ideas for new projects for the lab.

Nevertheless, most institutions involved in corporate-funded research report few restraints. In 1980 the German pharmaceutical company Hoechst pledged at least $70 million over a decade to create a new molecular biology department at Massachusetts General Hospital, an affiliate of Harvard Medical School. The contract gives Hoechst 30 days to review all manuscripts prior to publication, the right of first refusal to any licensing, and the right to clear all faculty consulting for industry or nonprofit groups. Dr. Harry Orf, director of the department's laboratories, says that his department has retained control of its research effort: "The department was careful to protect its right to function completely autonomously, to hire whomever we choose, to engage in whatever areas of research our faculty choose to, and to publish research with complete freedom."

For Tufts professor Krimsky, however, the dangers of increased corporate involvement are far-reaching. He identifies four different ways in which universities have traditionally treated the role of knowledge: as productivity, virtue, security, and as a social investment. With limited partnerships and other corporate agreements, says Krimsky, "one view—namely knowledge as productivity—is growing at the expense of others." □

SETH SHULMAN writes regularly for Trends. His most recent contribution was "Modem Madness."

New ways to commercialize academic research are transforming the relationship between schools and corporations.



Cure for the Winter Blues

His problems began when his family moved from Texas to Michigan. His schoolwork deteriorated each fall, and he virtually hibernated from mid-October until April, sleeping 16 to 18 hours a day. He gained up to 50 pounds during this period each year, consuming two dozen or more candy bars at a sitting. In spring and summer, the pattern would reverse: he'd burn off excess weight and sleep five to six hours a day. His schoolwork would improve and he'd be full of energy.

Afflicted with Seasonal Affective Disorder (SAD), this man now benefits from light therapy. For the past two years, under the supervision of psychiatrist Gary Sachs at Massachusetts General Hospital, the victim has alleviated his symptoms by spending two and a half hours, five days a week, in front of six fluorescent lights. From late September until early April, he sits there and reads, eats dinner, or watches TV.

Sachs has used light therapy on nearly 100 patients with seasonal depression, and 90 percent have responded

PHOTO: STU ROSNER; ILLUSTRATION: JON McINTOSH

Gary Sachs, a psychiatrist at Massachusetts General Hospital, is using light to treat people who become depressed in the winter.

well. "These people get better within one week of treatment," he says. Norman Rosenthal, a psychiatrist at the National Institute of Mental Health (NIMH), and his colleagues have successfully used the same approach to help 80 percent of their 250 SAD patients. It was Rosenthal who first identified SAD in 1981.

The effectiveness of light therapy for seasonal depression is surprising in view of the many unknowns regarding the condition. Scientists don't know what causes SAD, how many people have the disorder, or how to classify it medically. Nor do practitioners agree on the kind of light to use, the time of day to apply it, or how long to expose a person. But it is generally agreed that light therapy works, and that the most important factor is how much light a patient receives. The so-called Christmas blues may have less to do with Christmas than with people getting too little sunlight during the winter.

Enlightening Research

Scientists don't know precisely how light counteracts SAD, but they do know that it acts through the eyes rather than through the skin. When light strikes the retina, nerve pulses are sent to the suprachiasmatic nuclei (SCN) of the hypothalamus. From the SCN, a signal goes to the pineal gland, which secretes the hormone melatonin. This compound appears to play a key role in the disorder.

In the early 1960s, Richard Wurtman, director of M.I.T.'s Clinical Research Center, and his co-workers demonstrated that rats exposed to light secrete less melatonin. In 1980, Alfred Lewy, now at Oregon State University, showed that bright light has a similar effect on people. He also found that it takes less light to suppress melatonin in depressed people than others, suggesting a connection between certain emotions and the compound.

Other researchers tied melatonin, known to govern seasonal cycles in laboratory animals, to daily biological rhythms in humans, who produce more melatonin at night than during the day. But here the proven connection between SAD and melatonin stops. "Is seasonal depression related to melatonin?" asks Wurtman. "We still don't know."

Wurtman and his co-workers are also looking at the brain chemical serotonin as a possible link between seasonal depression and other disorders, including non-seasonal depression, obesity, bulimia, and premenstrual syndrome. They've found that, like SAD patients and bulimics, many obese people gorge on carbohydrates, which raises serotonin levels in the brain. "These people are using carbohydrates as though it were a drug," Wurtman says. In fact, every antidepressant drug increases brain serotonin.

Wurtman's experiments with rats have shown that melatonin affects the release of serotonin. However, Wurtman notes that "we still don't know whether melatonin causes the abnormal serotonin levels found in depressed people, or whether light has anything to do with it." Moreover, light therapy has proved far less effective for non-seasonal depression.

While some scientists are investigating the biology of SAD, others are exploring the link between behavior and light. Sachs believes that almost everyone needs a minimum amount of light to function properly, but that the threshold for SAD varies from person to person.

"There are probably ten times more cases [of SAD] in the northern parts of the United States than in the southern parts," says Daniel Kripke, a psychiatrist at the University of California at San Diego. He reasons that in the North "there's less sunlight in the winter or the temperature is keeping people indoors." But as with so much concerning SAD, he adds, "we don't know for certain."

Paul Gaist of NIMH thinks that in addition to needing light, "many, if not most of us, have seasonal variations." For this reason, he hypothesizes that "SAD may be an evolutionary mechanism which at one time was very adaptive." Like bears, people would "slow down in winter to save calories, gaining weight to store energy, moving inside . . . to conserve heat." □

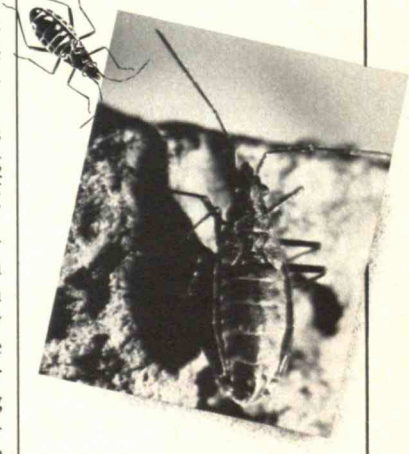
STEVE NADIS's most recent contribution to Trends was "Anti-Proton Fishing."

Bugs Versus Stars?

A flaming streak across a star-studded sky, Halley's Comet dominates the cover of the 1986 Honolulu phone book. Below the comet, four dome-shaped observatories sit atop the extinct volcano Mauna Kea, outlined by the first glow of sunrise. Barely visible are the endangered palila bird and the Hawaiian dark-rumped petrel, as well as native silversword, pukiawe, geranium, and mamane plants.

Not in the picture are some of Mauna Kea's tiniest and hardiest species. While they can survive the high winds, rainstorms, snow, and daily extremes of cold and heat at the 13,786-foot summit, it remains to be seen how they will cope with human invasions.

Development plans call for as many as 13 observatories to be sited on the mountain by the end of the century, in-



The tiny Wekiu bug is one of a dozen or so species threatened by development on Mauna Kea, a dormant Hawaiian volcano.

PHOTO: W. P. MULL

These entomologists are studying the Wekiu bug in its mountain habitat.

cluding the National New Technology Telescope, which will be the world's largest when completed. Eight observatories are operating now, with one more under construction. To protect the tiny organisms, the Hawaii Audubon Society, Mauna Kea Foundation, Sierra Club, Conservation Council of Hawaii, and others want to dispel the image of a lifeless summit. But officials at the University of Hawaii's Institute for Astronomy believe that the telescopes and the environment can coexist.

Wayne Gagne, an entomologist and natural-history specialist at Honolulu's Bishop Museum, is not so optimistic. He believes the heavy-construction activities could damage the habitat of the dozen or so species of mites, moths, booklice, barklice, spiders, springtails, centipedes, and other creatures. The insects live in an "aeolian" ecosystem, in which the main source of food comes from outside the system. Wind from lower elevations blows dead or dying insects up to the summit, where they are caught by snow packs and fed upon by summit fauna.

Flightless, about the size of a typewritten "1," the Wekiu bug is especially adapted to summit life. Named after the summit cinder cone Pu'u Wekiu on which it was first found, the jet-black bug inhabits cracks among volcanic cinders and ash. Gagne speculates that the Wekiu, found only in Hawaii, evolved from relatives that live at lower elevations, probably during the last ice age when snow covered more of the mountain.

An 1892 reference by naturalist H.B. Guppy provided Gagne with a clue to the existence of the Wekiu. In the British journal *Nature*, Guppy wrote of "parasitic bugs collected while they fed upon the bodies of dead butterflies." The reference puzzled Gagne until Bishop Museum scientist Frank Howarth rediscovered the bugs in the late 1970s. Gagne says that Wekiu are "quite secretive. You can get them more quickly by setting out traps than by spotting them."

Howarth says that a moth species, as yet unnamed, is similarly hard to find. Like the Wekiu bug, the moth is small, black, and hides among volcanic cinders. Unlike most moths, it comes out during the day to bask on sun-warmed rocks. It also eats small lichens and soaks up enough energy to leap tens of yards on its short, stubby wings.

Insects aren't the only specially adapted organisms on the summit. All but one of the lichens that moths feed on live among the cinders. The cracks, says botanist Smith, stay cool during the day and warm at night, and hold moisture that lichen need.

A Scoop of Wekiu

Since most summit organisms depend on the cracks and crannies among the cinders for protection, anything that alters the ground is harmful. Gagne and Howarth have noticed that unregulated off-road vehicles have compressed the cinders in several areas. Only preliminary proposals for stricter policies on such vehicles exist, although the Institute for Astronomy plans to put some into future management plans.

Unfortunately, the full environmental impact of the astronomy developments is hard to assess because few studies were made of the fauna before the observatories were built. In fact, Howarth discovered a few species only while helping prepare an environmental impact statement for one of the telescopes.

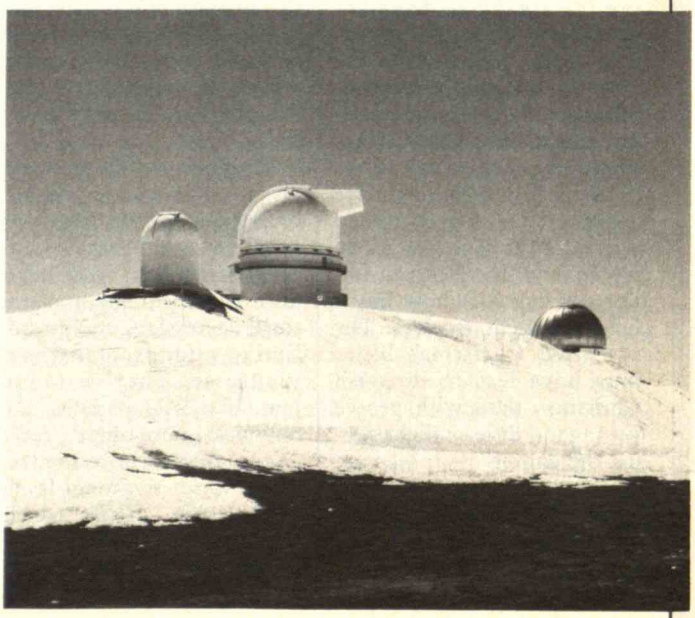
One danger from construction activities is that they stir up dust and may introduce exotic species into the environment. In addition, winter skiers may disturb the snow packs that catch the insects blown up from below. Hikers and skiers sometimes leave trash, which Smith warns could turn Mauna Kea into a "rubbish dump."

Some disturbances affect astronomy and the environment alike. Construction dust and diesel-generator emissions inhibit the view overhead. A diesel generator that provided power to the observatories was housed in an oil-leaking van next to one of the telescopes, but will soon be replaced with a power line to the summit.

Gagne notes that astronomers "begrudgingly agree" that "other values" exist on the mountain, but adds that if astronomers "came up with a scoop full of Wekiu bugs on Mars, there would be a big fuss." He considers it ironic that "here is something quite remarkable beneath their feet, and they consider it so mundane that it is hardly worth paying any attention to." □

STACY WONG is a Boston-based free-lance writer.

Eight observatories now sit atop Mauna Kea. As many as five more may be built by the end of the century.



PHOTOS: (TOP) W. P. MULL, (BOTTOM) W. C. GAGNÉ

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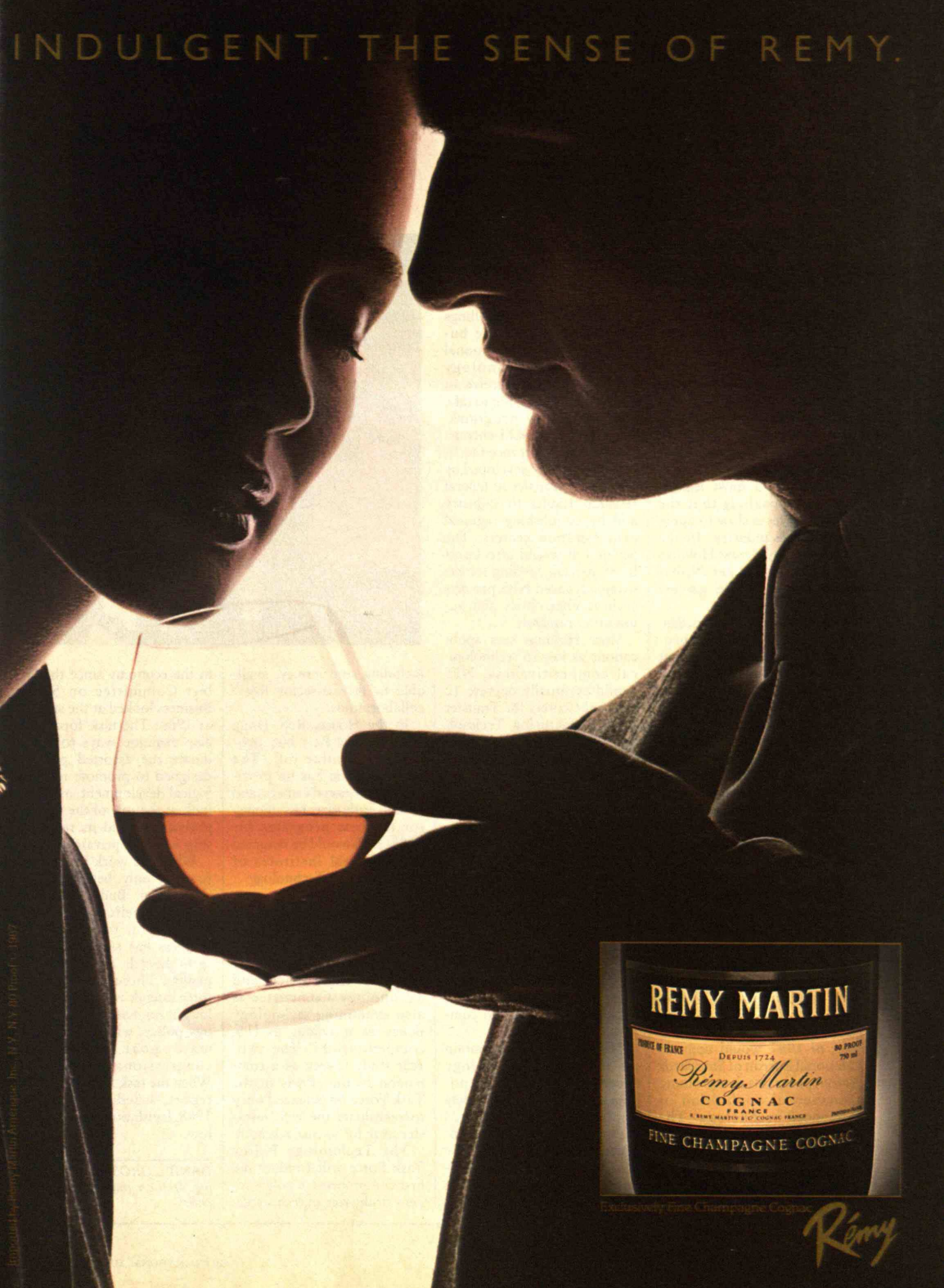

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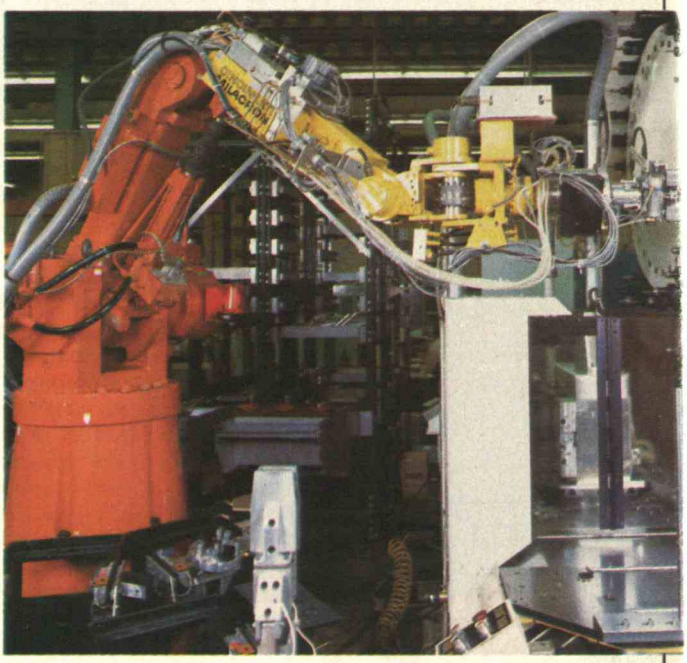

The National Bureau of Standards' "factory of the future" explores new ways to link automated equipment.

The Year of Living Competitively

Judging by this year's congressional agenda, the nation's most pressing technology issue is the competitiveness of U.S. industry. Both houses of Congress have joined the fray to consider the competitiveness/technology nexus. The rationale behind most legislators' proposals is that the United States is slow to apply research to industry. In the words of Sen. Ernest Hollings (D-S.C.), "We get Nobel prizes, the Japanese get the profits."

To deal with this issue, Sen. John Glenn (D-Ohio) proposed establishing a coherent technology and trade policy by remodeling the Commerce Department into a Department of Industry and Technology. Glenn's bill, which was defeated on the Senate floor, would also have created an Advanced Civilian Technology Agency to fund important research that the private sector might consider too risky financially.

The current Senate proposal, approved 20-0 by the Senate Commerce, Science, and Transportation Committee, has been incorporated into a 1,000-page omnibus trade bill. Sponsored by Hollings and Sen. Donald W. Riegle, Jr. (D-Mich.), the Technology Competitiveness Act of 1987 would upgrade National Bureau of Standards (NBS) programs that promote commercial application of advanced technology. The bill's fate, which is now tied up with that of the trade legislation, is expected to be decided this fall.

Symbolizing the new mission for the NBS, the Hollings bill would change the bureau's name to the National Institute of Technology (NIT). NIT would receive an additional $35 million to take on several new programs. Two of these would encourage the use of advanced technologies already developed by supporting transfer of federal research results to industry and by establishing regional demonstration centers. The Senate bill would also boost by 39 percent funding for existing advanced NBS projects such as fiber optics and automation research.

Since Hollings sees applications as key to technological competitiveness, NIT would eventually operate 12 regional Centers for Transfer of Manufacturing Technology. These centers would help transfer to private industry the automation technologies that NBS is developing in its Automated Manufacturing Research Facility in Gaithersburg, Md. This so-called factory of the future has applied new methods of measurement to link automated equipment. Since less than 10 percent of small and mid-sized manufacturing firms employ automation, the centers would demonstrate to managers how such equipment could increase their ability to compete.

NIT would also maintain an Advanced Technology Program to encourage the private sector to develop widely applicable, or "generic," technologies, such as standardizing protocols to improve the ability of different computers to communicate. The program would make grants, including seed money, available to private-sector R&D collaborations.

In the House, Rep. Doug Walgren (D-Pa.) has proposed a similar bill. The House version has no provisions for regional centers, and would authorize less money for the new programs for 1988. NBS would be renamed the National Institutes of Standards and Technology.

National Technology Policy?

Looking ahead, the Technology Policy Task Force of the House Science, Space, and Technology Committee is also examining technology policy as it relates to U.S. competitiveness. The two-year study is seen as a companion to the efforts of the Task Force on Science Policy to reevaluate the U.S. infrastructure for science research.

The Technology Policy Task Force will conduct the first comprehensive policy review of the role of technology in the economy since the Select Committee on Small Business looked at the subject in 1963. The task force will also examine ways to coordinate the assorted policies designed to promote technological development, and will look at the role of the federal government and its relationship with the private sector.

While the work of the task force is only beginning, its chair, Rep. Buddy MacKay (D-Fla.), believes that the "short-term mentality" of business has sacrificed long-term health for quarterly profits. Therefore, the task force intends to recommend a long-term national technology policy, which is the ultimate goal of all the congressional proposals. When the task force makes its report, scheduled for May 1988, legislation is sure to follow. □

DANIEL GROSSMAN is studying decision making in science policy.

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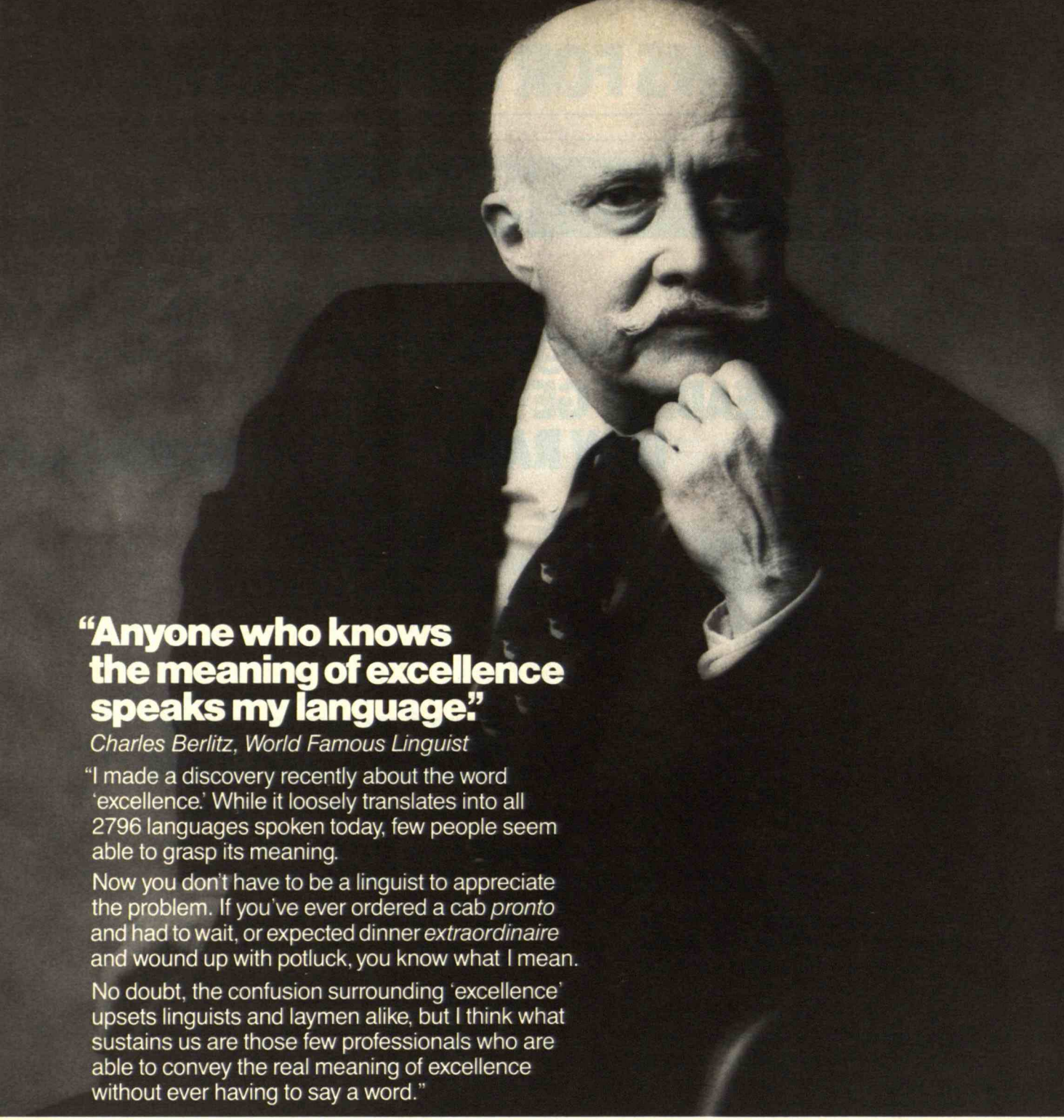

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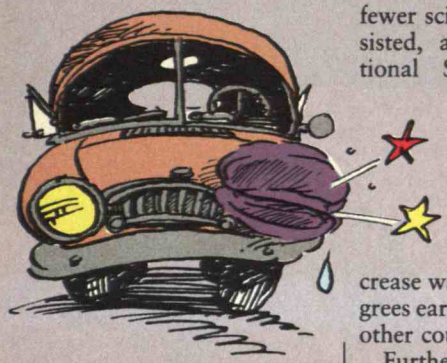

BLACK-&-BLUE PAINT

Paint developed by researchers at the Southwest Research Institute (SWRI) in San Antonio bruises when hit. The goal of the project is to produce paint that changes shades according to the strength of the impact. This would make it easy to see how much force a structure has encountered. As with human skin, the harder the blow, the darker the bruise.

"Many times materials will sustain damage, but look okay on the outside," says Glenn Light of SWRI's Nondestructive Evaluation Science and Technology Division. "Actually, the structure of the materials might be quite damaged." He thinks it would be more efficient "to look for these paint bruises, rather than scan an entire structure for damage."

First applied to materials for airplane wings and rocket-motor casings, the coating consists of dye-filled microcapsules mixed with paint. When a structure is hit, the capsules burst and the paint turns blue at impact points.—*Bob Carpenter*

MORE ENGINEERS

In 1986 the number of engineering doctorates awarded to U.S. citizens continued to rebound from a 1983 low, but a stronger trend toward fewer science doctorates persisted, according to a National Science Foundation survey. U.S. universities awarded 3 percent more science and engineering doctorates in 1986 than in 1985, but the increase was due entirely to degrees earned by students from other countries.

Furthermore, as attention to affirmative action has declined, so, too, has progress for women and blacks in science and engineering. Gains made by women seeking doctorates in science and engineering during the 1970s have slowed.

From 1970 to 1980 the number of women earning such degrees rose an average of 9 percent yearly. Since then, the increases have averaged only 4 percent. Blacks received 10 percent fewer degrees in 1986 than in 1985—about the same number as in 1980.

RECORDABLE CD

Researchers at the Philips Research Laboratories in Eindhoven, The Netherlands, have found that a promising group of materials could eventually lead to commercially available home recording with laser-optical systems such as compact discs and videodiscs. Such home systems now can play only pre-recorded discs.

The long shelf-life and insensitivity to normal temperatures and humidity of semiconductor materials such as gallium antimonide and indium antimonide makes the new materials suitable for repeated recording and erasing with a laser beam, according to Philips. In laboratory tests, information can be erased and re-recorded with these materials about a thousand times, enough for home consumers although insufficient for industrial purposes. The research is valuable because optical discs can store vast quantities of data.

UTILITY STRATEGY

Faced with possible power shortages in the 1990s, electric utilities are exploring ways to avoid building central power plants, say Douglas Cogan and Susan Williams. They are the authors of a report sponsored by the Investor Responsibility Research Center, a nonprofit organization funded by institutional investors. The survey covered 35 public and 88 investor-owned utilities, together accounting for 70 percent of U.S. generating capacity.

The study finds that escalating construction costs, competition, uncertain future demand, and the growing reluctance of regulators to allow for "imprudent" plant expenditures when setting rates are forcing utilities to regard building new plants as a last resort.

Utilities are counting on customer involvement in conservation and load-management programs especially in regions like the South, where reserve margins are diminishing fastest. On the other hand, two out of three investor-owned utilities surveyed indicate that their present sales objective is to increase electricity use overall or at off-peak times, even while four out of five of these companies implement programs to conserve electricity.

GET THE LEAD OUT

States spend millions each year on medical treatment and remedial education for children poisoned by lead, according to a study by the Conservation Law Foundation. "Preventing lead poisoning would be a far more effective investment," says Stephanie Pollack, an attorney and co-author of the study by the Boston-based nonprofit group.

According to the study, Massachusetts will spend $5,500 per child in 1987 to treat and educate 2,000 children expected to be poisoned by lead. Pollack proposes more comprehensive lead-poisoning prevention programs that would provide incentives such as loans, grants, and tax credits to homeowners and landlords to remove lead paint or lead-contaminated soil.

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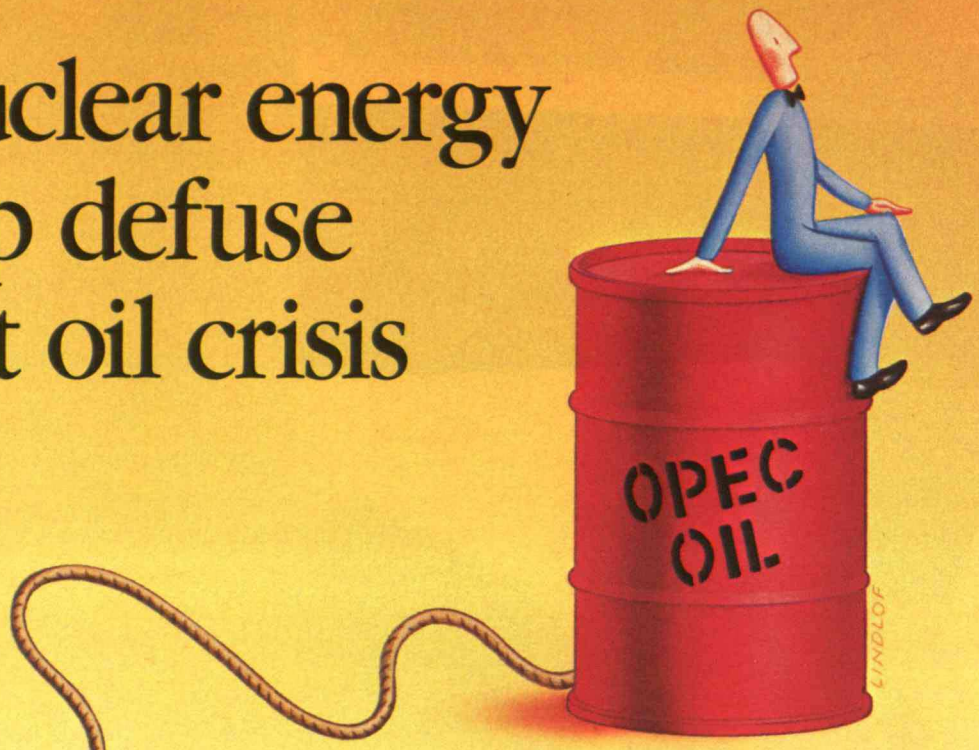
How nuclear energy can help defuse the next oil crisis



Nuclear-generated electricity, still the fastest-growing major energy source in America, may be our best defense against another oil crisis.

More and more energy experts are asking the same question: How long before another oil shock torpedoes our economy and threatens our national security?

Oil turmoil

Signs of the next energy crisis:

- U.S. oil imports soared last year, costing the country $27 billion. This year, America's foreign-oil bill is expected to grow even bigger.
- Many oil analysts are saying that in three years or less, as much as 50% of all the oil used in the U.S. will have to be imported. That's a higher percentage than we have ever imported before, even during the oil crises of the 1970s.
- A whopping two-thirds of the world's oil lies under the sands of OPEC nations.

The need for nuclear

Nuclear electricity is a *domestically produced alternative to foreign oil.* Not just at the power plant, where nuclear energy is used instead of oil to generate electricity, but wherever Americans choose electricity (instead of oil) to heat their homes or run their factories.

The 1987 special report on U.S. energy security, ordered by the President and prepared by the U.S. Department of Energy, states that without electricity from nuclear energy, the United States "would be using more oil, paying more for each barrel of it, and feeling much less secure about its energy outlook."

The more we use our own nuclear electricity, the less we'll have to rely on energy from unstable regions of the world.

Nuclear energy for a secure future

With over a hundred operating plants in the U.S., nuclear energy is now our second leading source of electricity. But in spite of all that we have accomplished, the threat of foreign oil dependence remains. Difficult choices still need to be made, but one fact is clear: the more we develop our own energy sources, the more we can control our own destiny.

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ROBERT C. COWEN

Mapping the Nation's Underseas Wealth

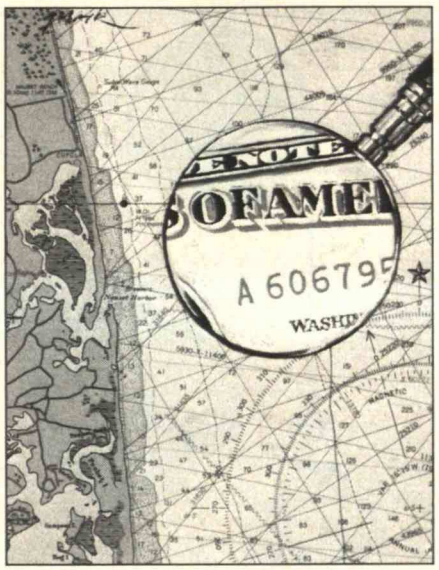
FOUR years ago, when President Reagan asserted U.S. sovereignty over the zone stretching 200 miles from the nation's coastlines, some observers compared the annexation to the Louisiana Purchase. The 1803 acquisition doubled the country's size. The offshore area, known as the Exclusive Economic Zone (EEZ), is 86 percent as large as the nation's land area.

As the congressional Office of Technology Assessment (OTA) emphasized in a study issued last July, it's time the United States found out what it has gained. Belief is widespread that the undersea territory, which was annexed in accord with common international law, has vast mineral riches that might make the country self-sufficient in such critical elements as cobalt, chromium, manganese, platinum, and gold. But just a "minuscule portion" of this frontier has been explored, OTA points out. "Little credence should be given to estimates of the economic value or tonnages of seabed minerals inferred by some observers."

A host of military, bureaucratic, economic, and legal problems are preventing the United States from learning details about the minerals in the EEZ. The nation needs a modern offshore minerals law that calls for an effective research and mapping program.

Until now, the vision of a seabed bonanza has been based mainly on speculation fueled by a few intriguing discoveries. For example, crusts up to four inches thick containing manganese, cobalt, nickel, copper, chromium, and platinum are believed to cover tens of hundreds of square miles in places, especially off such Pacific islands as Hawaii. (Twenty-one years ago the Reynolds Submarine Service Co.'s submersible *Aluminaut* hyped a manganese deposit off the southeastern United States by wheeling along an underseas "highway.")

Scientists also know that the EEZ includes beds of phosphorite, useful as fertilizer, and "placers"—loose accumulations of sand and gravel containing gold, platinum, and other metals.



It's high time the United States learned how much wealth lies along the coastlines on the ocean floor.

As OTA states, these hints of undersea treasure pose an "immediate challenge" to "gain a better understanding" of the seafloor and to inventory its minerals. Echo sounders and other modern instruments can produce comprehensive data banks. Computer processing can transform the data into detailed, three-dimensional, topographic maps of the seafloor to aid prospecting in addition to oceanographic research.

The trouble is that such maps can also help enemy submariners figure out where to hide their craft. The navy has long wanted to keep underseas maps fuzzy. It has even suggested deliberately distorting the data in a random fashion, according to OTA.

The government's civilian EEZ mapping and resource-cataloguing efforts to date hardly threaten the position the Department of Defense (DOD) has taken. The most extensive work, conducted by the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, is just a small start. And the 10 or so other agencies involved with EEZ exploration are making matters more confusing. They don't always archive information carefully, so not all of it is readily available.

Industry might have pressed harder for better mapping years ago if the economics of seafloor mining were more favorable. But the sea is generally a more severe environment in which to work than the land. "The commercial prospects for developing marine minerals . . . appear to be remote for the foreseeable future," the OTA report states. This is especially true for minerals in the deep-water portions of the EEZ.

Nevertheless, developing the capacity for mining is still important, in case political or military conditions suddenly change. DOD—which depends on equipment that uses critical minerals—should encourage accurate mapping.

In addition to economics, legal uncertainties may be holding up the exploitation of EEZ minerals—and therefore forestalling a big drive for thorough mapping. While the 34-year-old Outer Continental Shelf Lands Act (OCSLA) now regulates EEZ mining, it is oriented toward sulfur, oil, and gas because knowledge of hard minerals on the seafloor was scant when the document was written. Would-be prospectors want regulations that address their interests in hard minerals specifically.

Rep. Mike Lowry (D-Wash.) has introduced legislation to do this. His National Seabed Hard Minerals Act would also start systematic research to map the EEZ and assess its mineral wealth. To assuage coastal states that might think they have a right to some of the action, the act would require that miners share royalties with them. The bill's fate was unknown as of mid-September.

The Reagan administration, which dislikes the revenue-sharing aspect and some other provisions of the bill, opposes it. Through the Department of Interior, the administration has been finishing its own hard-minerals regulations. But since they will be based on existing law, they will not substitute for Lowry's minerals act.

Like the Louisiana Purchase, the EEZ challenges the United States' capacity to plan ahead. Large-scale payoffs from EEZ minerals probably could not come until the next century. But the country must start laying the legal and scientific foundation for mineral exploitation now. □

ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS.

ILLUSTRATION: PAUL MOCK

LESTER C. THUROW

Why the Dollar Will Fall

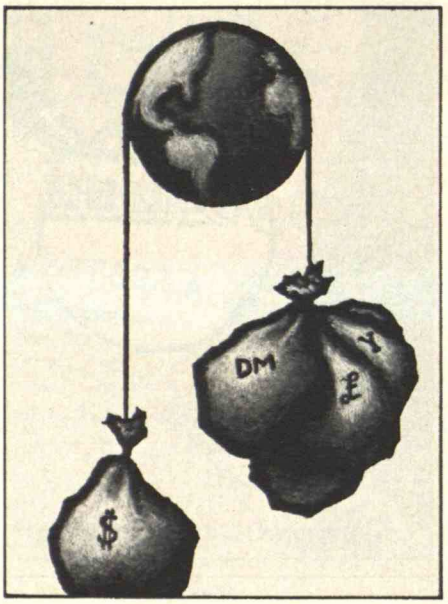
THE Federal Reserve Board has been raising interest rates to keep the dollar up and inflation down, but this policy is a long-run loser. The dollar must be allowed to fall now or it will fall later—with larger reductions in our standard of living and more inflation.

Since March of 1985, the dollar has fallen 35 percent in value, and more against many currencies such as the West German mark. A falling dollar should decrease the price of U.S. exports and increase the price of imports, encouraging foreigners to buy more of our products and discouraging us from buying theirs—thereby improving our trade balance.

However, the trade deficit for the first half of 1987 was higher than for the first six months of 1986. If there had not been a technical correction in the way the data are collected, June's deficit would have been the worst ever. Some economists predict that the trade deficit for all of 1987 will exceed that for 1986, and almost everyone predicts that the current account deficit (which includes interest payments on foreign debt) will increase in 1987. Why hasn't there been a big improvement in the U.S. balance of payments?

There is a conventional explanation for why the balance of payments does not instantly improve as the value of a currency falls. It is the "J" curve. When the value of a currency falls, import prices rise and export prices drop immediately; only later does the volume of exports or imports have time to change. The sudden rise in import prices leads to a temporary deterioration in trade balances. The trade deficit does not improve until the actual volume of exports has a chance to increase in response to lower prices and the volume of imports has a chance to decrease in response to higher prices. The name J curve comes from the fact that a falling currency leads first to a deterioration in the trade balance (the downward part of the J) and only later an improvement (the upward part of the J).

The dollar, however, has now been falling for two and a half years—long enough to have noticeably changed the volume of exports or imports. More important, the rise in import prices assumed by the J curve has not occurred. Americans who buy a Japanese automobile should pay more dollars if the manufacturer is to receive the same number of yen. But surprisingly, import prices have risen very little relative to domestic prices. Foreign firms have held prices constant and accepted losses to hold on to their American sales.



The dollar must fall now, or it will fall harder later—and pull our standard of living down with it.

Exports of some commodities such as bulk chemicals have risen, but imports have continued to grow faster than exports. The net result is no improvement in the balance of payments.

Oil explains part of the lack of improvement. In 1986 firms cut back on oil imports to get rid of inventories that were falling in value. This kept the 1986 trade deficit down to $156 billion, instead of the $180 billion that it would otherwise have been. Conversely, the 1987 trade deficit has increased because both the volume and price of imported oil are rising.

Disappearing agricultural markets have played a role in increasing the trade deficit, too. In the early 1980s the United States exported almost $30 billion more in agricultural goods than it imported. But with the success of high-yield crops introduced in the Green Revolution, many Third World nations now produce all the grain they need. In addition, Common Market agricultural subsidies have led to big increases in production for these countries. The net result is a large reduction in our agricultural trade surplus—a falling dollar cannot reduce Third World production or lift Common Market subsidies or restrictions.

Lackluster growth in the rest of the world also makes it very difficult to increase U.S. exports. If the German gross national product (GNP) is declining, as it has been in recent quarters, the dollar must fall just to hold American exports constant. The same slow economic growth has helped to keep U.S. imports from decreasing. Foreign firms simply have nowhere else to sell their output.

Moreover, the dollar has not fallen much against some key currencies such as those of Canada (America's largest trading partner), Korea, and Taiwan. The latter two countries have used the rising value of the yen to take market share away from Japan. Japanese exports of TV sets are down, for example, but U.S. imports of TV sets are not. What used to be exported from Japan is now exported from Korea or Taiwan.

The prolonged high value of the dollar in the first half of the 1980s caused many U.S. firms to stop producing certain items or to refrain from introducing new ones such as video recorders. Now, regardless of the value of the dollar, Americans must import these goods. American firms are also reluctant to open up domestic production facilities, since those "foreign" imports often come from their own offshore factories. Much of what is imported into America is in fact made by American firms. For example, Ford imports the Mercury car from its German subsidiary.

The dollar has much farther to fall. That is clear since its current value is not improving the U.S. balance of payments. At some point, foreigners will quit lending to the United States. At that point, the country will run out of funds with which to buy foreign currencies to buy imports, and the value of the dollar will fall.

ECONOMIST LESTER C. THUROW IS DEAN OF THE SLOAN SCHOOL OF MANAGEMENT AT M.I.T.

ILLUSTRATION: BRUCE MADDOCKS

Just how much farther the dollar has to fall is unclear. The standard econometric models can predict marginal changes within a stable economic framework, but these changes are too major to analyze using conventional methods. Basically, import prices must rise enough to persuade Americans not to buy $156 billion in imported goods and services. In addition, the dollar has to fall enough to allow the United States to generate a trade surplus large enough to give it the funds to pay the interest on its international debt.

This means further rises in the value of the German mark and the Japanese yen. It is just a guess, but I think that it will take something like 100 yen to the dollar and 1.1 marks to the dollar to do the job. And it is also necessary to alter the system whereby Korea and Taiwan peg their currencies to the dollar. These currencies will have to rise substantially.

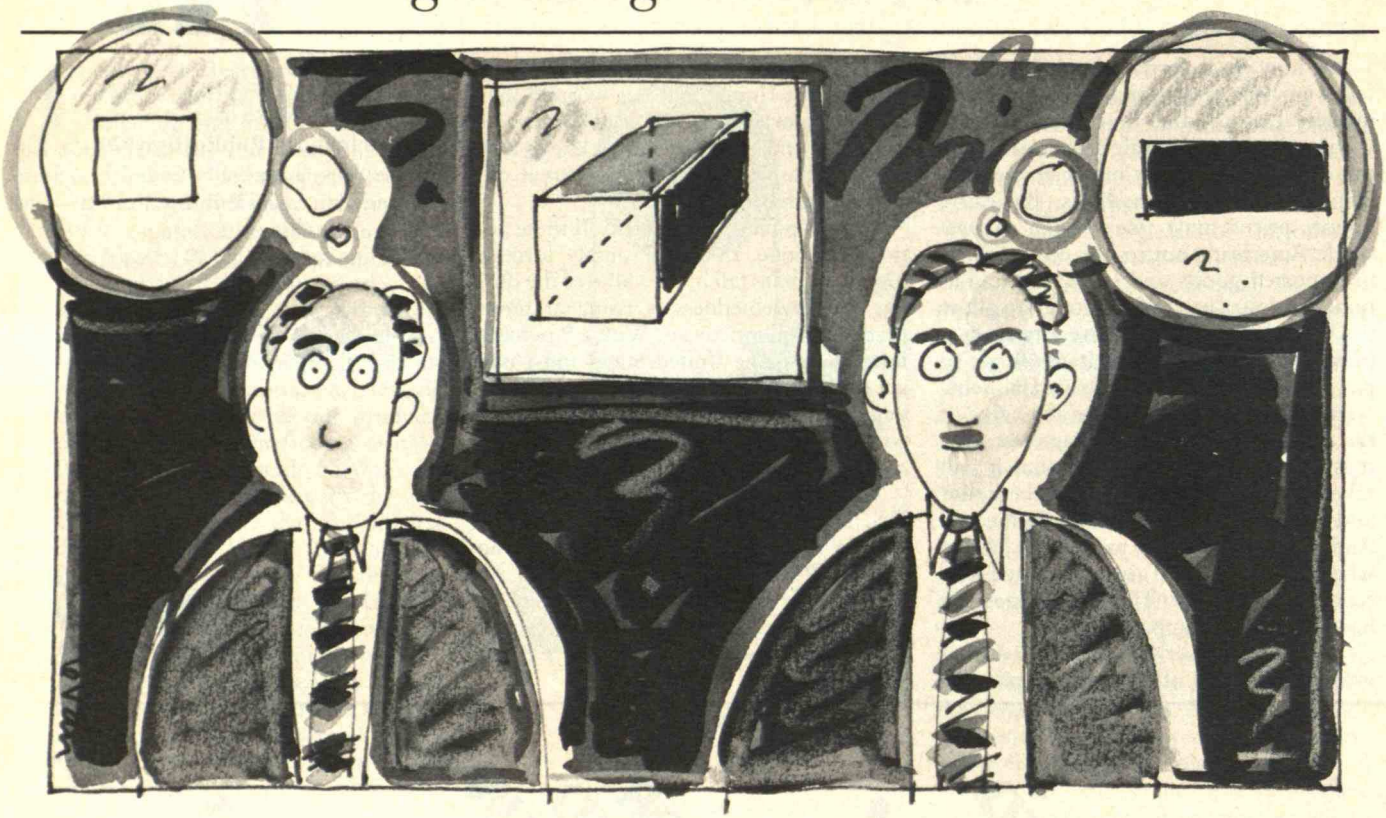
The Federal Reserve Bank is now raising interest rates and other central banks are intervening to keep the dollar from falling farther. The United States is worried that higher import prices will lead to general inflation, and other countries know that they will lose their export markets if the dollar continues to fall.

But this policy is misguided. If these actions continue, they will simply force a bigger ultimate fall in the value of the dollar. U.S. indebtedness is rising at more than $150 billion a year. With a 9 percent interest rate, the United States must pay an extra $13.5 billion in interest every year. That requires the dollar to fall enough to produce an extra $13.5 billion trade surplus.

The result is more inflation and a lower U.S. standard of living in the long run, since a larger and larger fraction of the U.S. GNP will have to be used to pay interest to our foreign bankers. A decline in the dollar now will be painful, but it would be more painful to wait and face a much larger decline in the future. □

BY DANIEL GOLEMAN

Failing to Recognize Bias in Science



DESPITE all we hear about scientific fraud, most scientists can rest comfortably in the knowledge that they would not set out to deceive. Yet anyone, even the best-intentioned scientist, may unknowingly contribute to falsehoods. Sometimes wishful thinking can override the facts.

Michael Mahoney, a psychologist now at the University of California at Santa Barbara, discovered this in the 1970s. Then at the University of Pennsylvania, Mahoney sent two versions of a fictitious study to reviewers who were to help decide what would be published in a psychology journal. The versions were identical in all respects except that the numerical findings were reversed and the conclusions differed. One confirmed a hypothesis sympathetic to the school of thought favored by the reviewers, who were behaviorists.

The reviewers who received the paper sympathetic to their views universally recommended that it should be published.

Scientists with unusual ideas may find it tough to win funds or publish results because of others' preconceptions.

Those who read the other paper were adamant that it should not be published. Rather than opposing the results outright, they criticized the paper on methodological grounds.

Although complaints about favoritism are part of the underground gripe network of any branch of science, many researchers would not admit to being influenced by such considerations. Passion and prejudice are supposed to hold no sway in science, but these forces operate in the researcher as much as in anyone else. Indeed, the failure to acknowledge the danger of self-deception actually adds to the harm. Precisely because they see their profession as a realm of utter rationality, scientists may be unprepared to recognize the ways in which irrationality can twist science.

How might a well-meaning scientist fall prey to self-deception? The answer has to do with how the mind processes information. When we are challenged by new ideas, our minds may be able to censor them before we are aware of it. Indeed, the mind may be particularly adept at filtering out disagreeable concepts.

Recent advances in cognitive science demonstrate that the vast majority of information processing goes on outside the conscious part of the mind. This saves us from bothering with trivial detail. But it also means we can miss telling facts.

In 1982, Ulric Neisser, a cognitive psychologist at Emory University, made a one-minute videotape to demonstrate how we continually select what will fall within our narrow beacon of attention. In the tape some men pass a basketball between them. At one point, a young woman in a white dress who carries a white parasol walks through the game. She is on the screen for four full seconds. Neisser showed the tape to dozens of people, asking them to count how many times the men pass the basketball. Afterward, he asked if the observers saw anything unusual on the tape. Almost no one noticed

DANIEL GOLEMAN, a psychologist who contributes regularly to the New York Times, *is the author of* Vital Lies, Simple Truths: The Psychology of Self-Deception *(Simon & Schuster, 1986).*

ILLUSTRATION: SUSAN LEVAN

the woman with the parasol.

The failure to see the woman is a by-product of selective attention—a one-pointed focus that is essential for concentration. Unfortunately, this mechanism can keep important but threatening information from our awareness.

The classic demonstration of this process—which can be called "motivated inattention"—is a study done by Lester Luborsky of the University of Pennsylvania. In work reported this year, he tracked the eye's movement as it scanned an image. From psychological tests, Luborsky knew that some of his subjects were prone to repress thoughts that might make them anxious. The experiment showed remarkable evidence of repression in these people.

Take the performance of one man who the tests revealed was anxious about sexuality. When shown a sketch that had a woman's naked torso in the foreground and a man reading a newspaper in the background, he did not let his eye fall near the torso. When later asked what had been in the picture, he did not recall the woman.

Such findings suggest that the mind is quicker than the eye, and that it can edit information before it enters our awareness. That makes self-deception possible. Motivated inattention leads the mind to shift its focus, particularly when an idea is unpalatable. This phenomenon may well be at work when the reviewers of an article that challenges their scientific beliefs recommend against publication because of "methodological difficulties."

It may also explain why so many scientists have clung to favored theories in the face of overwhelming evidence to the contrary. George Ohm, who discovered the law of electrical resistance, was ignored at the major German universities of his day because he was seen as a lowly secondary-school math teacher. For almost 40 years after the German meteorologist Alfred Wegener proposed the theory of continental drift, geologists resisted it, despite the increasing abundance of evidence.

Of course, most scientists give credence to new and unexpected findings, and modify or discard old theories. And some obstinacy may be healthy skepticism. Often scientists have sound reasons to hold onto a theory despite apparent evidence to the contrary. But when allegiance to a theory leads to dismissal of compelling facts, self-deception is at work.

Self-deception might be remedied by reforms in the peer review process, which is used for deciding on project funding and for determining what scientific information will be published.

At the funding stage, prejudices about theories might be lessened if reviewers financed some researchers without considering their proposed work. They might consider scientists' records instead. Such an avenue is being used by the John D. and Catherine T. MacArthur Foundation, which awards grants based on people's demonstrated potential for creative work.

Peer review at the publishing stage could be structured somewhat like a double-blind study, in which experimenters do not know what hypothesis they are testing or whether they are handling the active ingredient. For example, some reviewers might evaluate only the methods section of a paper, without knowing the results. That way those whose covert objections concerned the direction of the results or the nature of the theory could not disguise their disapproval by attacking the method. Such an approach, because it is more cumbersome than the usual peer review, might be used only when an author thought bias might be a problem.

Another antidote would be to have reviewers sign their evaluations, so that they would have to stand by their critiques. Of course, there is the danger that reviewers would then accept everything, fearing that anyone they rejected would reject them later. To protect against that, the author could be told who the reviewers were—so obvious ringers could be spotted—but not which way they voted.

If reviewers were identified, an author who believed one of them might have a bias could raise that objection. Making the names of reviewers known might serve another purpose as well: those too involved with the author, whether friends or enemies, could be more easily weeded out.

Under the current system, scientists may face special difficulties in convincing reviewers who hold the prevailing view to allow particularly innovative findings into print. The irony is that researchers with the most important ideas of all—truly revolutionary perceptions that point to an entirely new theory or paradigm—have the hardest time reaching their peers. Science would be healthier if it relied on a system that was better at limiting self-deception. The pursuit of truth requires a free flow of information, no matter how unpalatable that information might be. □

Recycling: Coming of Age

THE bowl of evergreens encircling a short stretch of Route 101 in southern New Hampshire might seem an unlikely spot for a garbage crisis. The ample open land suggests that somewhere among the slight hills could be found a landfill site where trash could be unobtrusively sequestered.

And Wilton, N.H., might seem an unlikely town to have chosen mandatory recycling to solve its solid-waste dilemma. Residents of the area are fairly conservative, many of them long-timers joined by an influx of people largely employed by the region's high-tech companies. People living there seem to take the state motto "live free or die" entirely to heart. They don't like to be told what to do and resist government involvement in their lives.

Until 1979, Wilton did depend on a landfill of sorts—an old stone quarry where the town had long dumped its trash. As in many rural communities, the landfill was "treated with benign neglect," says town councillor Greg Bohosiewicz. Fires were regarded as "acts of God" that lowered the ever-growing piles of garbage, he points out. The strategy worked until the mid-1970s, when the state began pressuring Wilton to close the landfill because it sat on the banks of a river. The town faced a number of options, none of them easy: open a proper landfill, export the waste, incinerate it, or recycle it. Enter Bohosiewicz, then "just an interested citizen."

BY BARBARA GOLDOFTAS

Recycling programs are taking off around the country, prompted by the solid-waste crisis and more sophisticated ways of handling and selling the materials.

"The only thing I knew about trash at the time was that it magically disappeared someplace," he says. As a citizen, he wanted to keep taxes low. As an economist by training, he quickly realized that recycling was the cheapest alternative for dealing with the town's trash. Working as a "one-man committee," he sold the idea of a joint recycling center to six towns in the area. The center opened in Wilton in 1979, accepting materials ranging from aluminum foil to bottles and cans, plastic milk jugs to compost. Today about 65 percent of the area's population recycles — a high participation rate for a drop-off program. Wilton spends about $36 per ton to dispose of its waste, compared with $120 per ton in a neighboring town that does not recycle.

Wilton, N.H., saved $100,000 in disposal costs last year by requiring citizens to separate a wide range of recyclables.

The Wilton program is part of a growing national trend toward recycling. At least 14 states, primarily in the Northeast, West Coast, and mid-Atlantic regions, have passed legislation that either promotes or requires recycling of residential garbage. More than 500 communities offer curbside collection of glass, paper, metal, and other materials.

Oregon recycles about 20 percent of its waste, and all towns there with 4,000 or more people must offer curbside collection of recyclables. New Jersey, which recycles about 15 percent of its rubbish, passed a law this spring requiring towns to set up recycling programs for leaves and at least three "marketable waste materials" of their choice. New York State and Philadelphia recently set goals to reduce their garbage by 50 percent by 1997, partly through recycling programs.

Residents drop off old books, motor oil, car batteries, plastics, and organic waste, as well as newspapers, metal, and glass.

Recycling appears to be entering a new era both politically and economically. The wave of programs that accompanied the environmental movement in the 1970s tended to be small, private ventures that relied on volunteer labor. Many struggled because revenues proved difficult to make from limited quantities of used glass, paper, metal, and the like.

Today profits are generally not the bottom line, and environmental concerns are not the primary motivation. The new programs tend to be run by the public sector, which is spurred by steeply rising tipping fees—the cost of unloading garbage at landfills or incinerators—and an overabundance of garbage that has no place to go. The private sector, which is active in processing, incineration, and—in "bottle-bill" states—collecting bottles and cans, has steered clear of municipal collection programs, mainly because lower disposal costs generally do not accrue to private companies.

"Wherever there aren't huge open spaces, waste disposal costs are the fastest rising item on any municipal budget," says John Schall, the recycling director at the Division of Solid Waste in Massachusetts. "In the Northeast it's starting to cost so much for disposal that you don't even need to bring in revenues for the recyclables," says John Purves, former director of solid-waste disposal for New Jersey's Camden County. "You just need to get them out of the waste stream."

Many officials facing solid-waste crises see recycling as a way to dispose of garbage without raising taxes. Judy Roumpf, publisher of *Resource Recycling,* one of two magazines devoted to the topic, says that the public sector has come to the "gradual realization that although recycling costs, it is less costly than collection or disposal of waste."

Advent of the Throwaway Culture

Public recycling programs have been in place for years in countries such as Germany and Japan—in part because they are strapped for both raw materials and space. Communities in both these countries recycle 50 to 60 percent of their solid waste. Bernd Franke, head of the Institute for Energy and Environmental Research in Takoma Park, Md., believes that public attitudes and education are critical to successful levels of recycling. Before recycling was introduced to several German towns, he says, people asked 'Who is going to do this? They're too lazy.' " Now 95 percent of the population there recycles.

Some Tokyo suburbs recycle more than 50 percent of their refuse, with residents separating waste into numerous categories. In fact, recyclables there are not perceived as garbage. In much the way that Americans often sell or give away old cars, clothes, and

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PHOTOS: HOLLY VANCE

Once a typical town dump, the Wilton recycling center now looks more like a summer camp.

books, Japanese citizens set aside materials such as glass, paper, metals, and household hazardous waste for processing and reuse.

Even in the United States, often criticized for being a throwaway, consumerist culture, indiscriminate disposal has a short history. In New York City in the late 1800s, scavengers were paid to "trim" the garbage of materials they could sell. In the mid-1890s, street cleaning commissioner George A. Waring tried to recapture some of these resources for the city to help defray the costs of waste disposal.

Called "the Apostle of Cleanliness," Waring understood the link between sanitation and public health and directed street sweepers to wear white uniforms to help the public make the same connection. Although incineration (then called cremation) was becoming popular, Waring introduced an ambitious recycling program, and in 1898 established the city's first plant to sort garbage and reclaim recyclables. According to a recent report by the New York State Legislative Commission on Solid Waste Management, between 1902 and 1924, 50 to 83 percent of U.S. cities separated some items for reuse.

During World War II, the loss of overseas sources of raw materials gave recycling a boost. Households routinely saved tin cans, glass, and other products. At least one-third of all paper was recycled during the war, along with copper, aluminum, and other strategic metals. Glass bottles and jars were refilled as many as 40 times.

As international trade in strategic metals resumed after the war, recycling declined. In the 1950s and 1960s urban "source-separation" programs were cut back, and by the mid-1960s most cities collected mixed garbage. Although some cities still picked up yard waste, separation of other materials was considered too expensive compared with the seemingly low cost of using landfills.

In the early 1970s, recycling began to rebound, spurred by concerns about diminishing natural resources, especially fossil fuels. Neil Seldman of the Institute for Local Self-Reliance in Washington estimates that more than 3,000 recycling centers were created during that time. Largely because of their size, these programs usually couldn't offer the reliable supply of materials necessary to attract secure markets. Most didn't survive the 1974–75 recession and the dip in prices for "secondary" materials that followed.

Wooing the Public

To ensure a steady supply of materials and reduce the volume of garbage, today's recycling programs try to enlist the active support of a large portion of the population. Approaches to wooing the public vary. In rural areas that lack the luxury of municipal refuse collection, residents already drive to the town dump or hire a hauler. So drop-off centers like Wilton's—where citizens bring all their refuse—require only the extra step of separating the recyclables. Center director Patricia Moore says that most people don't seem to mind the extra work, but those who do—about 35 percent—pay to have their trash taken elsewhere.

Each town pays a fee for using the center based on the size of its population, and also shares in the revenues from selling recycled materials. Moore estimates that Wilton saved $100,000 in disposal costs last year.

One of the center's outstanding traits is its cleanliness. Once a typical town dump, it now looks more like a summer camp with a tidy, litter-free parking lot, wind chimes, and a cluster of low, pre-fab barns. There's hardly an unpleasant odor. Wooden trays, each larger than a double bed, brim with aluminum cans, tin cans, brown glass, clear glass, and green glass. Hand-painted signs specify what goes where.

Bins at the front of one barn collect cardboard, newspaper, and mixed paper. At the far end of the lot stand a discarded vacuum cleaner and other appliances, a shelf bearing old books and a few shoes, jugs of used motor oil, several rows of car batteries, scrap metal, and a dumpster filled with organic waste for composting. People also drop off unwanted clothes, styrofoam packing pellets, and milk jugs and soft-drink containers made of PET

An employee of the Wilton recycling center stockpiles wood chips, which are sold to residents and businesses for landscaping.

Reclaimed aluminum is formed into coils for reuse. A recycled can is back on the supermarket shelf in 6 weeks.

(polyethylene terephthalate—one of the few recyclable plastics). A huge dumpster under a barn roof contains items that will be incinerated on site—disposable diapers, computer printouts, most plastics, and paper contaminated with food.

The center recycles about half the garbage it receives—a huge proportion for most such programs. About 35 percent is burned, and the remaining 15 percent, including the incinerator ash, is landfilled.

Urban Recycling Mecca

In contrast to the Wilton program, which collects many different materials, urban programs tend to focus on convincing a broad range of citizens to separate a few recyclables. Many programs offer curbside pickup during regular garbage collection and use extensive public education.

Reclaimed cans are baled and then melted. Manufacturers use 95 percent less energy to recycle aluminum than to smelt it from bauxite ore.

In the Northeast, New Jersey is almost a mecca for recycling. The most densely populated state, it faced landfill and toxic-waste problems early. It also contains an ample network for recyclables: dozens of industries, including paper and glass mills, use secondary materials, and more than 90 private dealers process waste paper, glass, and steel.

The state has increasingly pressured its 21 counties, which handle their own trash, to curtail the amount of solid waste they generate. In 1980 the state set a goal of reducing its waste by 25 percent and created a system of grants and loans to help counties launch recycling programs. The recycling office in Trenton, the state capital, also introduced Mr. R. E. Cycle, a magician featured on posters and bumper stickers who visits schools to teach students about the feasible magic of recycling.

Recycling has been mandatory in Camden County, N.J., since 1985. According to John Purves, former director of the county's program, "Before Camden, people didn't think that major recycling could work and be economically feasible." With a population of half a million, the county stretches from the relatively unpopulated Pine Barrens to the economically depressed city of Camden, which sits on the Delaware River opposite Philadelphia (whose own garbage problems often spill over into New Jersey).

Camden's recycling efforts were spurred in 1984 when a landfill used by 26 of its 37 towns threatened to close. Officials soon discovered that other nearby sites charged dumping fees three times as high. The solution: since 1985 all towns have had to recycle newspapers, aluminum cans, scrap metal, used oil, and yard waste. Some form of curbside collection is also mandatory. All but two towns pick up newspapers, and most collect bottles and cans, which they send to a central processing facility in Camden city.

Each town takes a different approach to encouraging citizen participation. Voorhees Township on the edge of the Philadelphia suburbs boasts a 100 percent participation rate. The tactic is simple: to have trash picked up, residents must put out the recycling pail distributed by the town, whether or not it contains bottles and cans. If they don't, the trash is left behind, labeled with a red tag.

The program in suburban Haddonfield has evolved into one of the county's most successful. The town opened a drop-off center for recyclables in 1981, and quickly moved to twice-monthly and then weekly pickups after dumping costs more than tripled. In addition to collecting bottles, cans, and newspapers, Haddonfield picks up "white goods"—old refrigerators, stoves, and other major appliances. Last year it collected 33 tons that were sent to scrap dealers in Camden city. The town also collects leaves and wood—2,200 tons and 1,000 tons, respectively, in 1986—chipping the branches, tree

PHOTOS: REYNOLDS METALS, ALCOA

trunks, and other scraps for composting.

Each time curbside collection added another item or more frequent pickup, participation jumped. The drivers of the recycling trucks, who measure compliance with hand counters, estimate that 70 percent of all households recycle on any given day, and that only about 5 percent never do. Says borough administrator Richard Schwab, the drivers "know the town like the milkman"—who doesn't recycle, who recycles sometimes, which senior citizens share recycling buckets with their neighbors because they don't produce much trash. The town of 2,000 last year recycled 40 percent of its waste, saving $65,000 in tipping fees and reducing the total cost of waste disposal by $23,400.

Some communities in other states tackle recycling with a combination of programs rather than one comprehensive effort. A successful buy-back center in the Bronx pays people for their materials—an important incentive for many low-income residents. It accepts any quantity of most materials other than clothes and tires, including wood and several plastics. More than a year old, the program brings in over 100 tons per month.

In San Francisco, public and private programs each reach a distinct community or involve a different commodity. The programs almost sound like an array of rock groups: Encore picks up and sells wine bottles; Many Happy Returns buys back materials; Zoo Doo recycles zoo manure as compost. Others target Latin, black, and gay and lesbian communities. Recycling coordinator Amy Perlmutter says that the city's motto is "something for everyone." Her goal is to "figure out what would motivate a particular community and try to tailor solutions to suit the problems."

In Massachusetts recycling has been designed to work on a large scale. The Division of Solid-Waste planned a streamlined program, now operating in several communities, that ultimately is expected to be used across the state. Residents set out paper, glass, metal, and cardboard in a single container. The communities must make recycling mandatory, collect the materials, and offer ongoing public education. Regional processing plants similar to the one operating in Camden will separate and market the materials. "We created a model that is generalizable," says recycling director Schall. "Each community won't have to reinvent the wheel."

Like most towns that recycle, New York City uses public education to encourage participation. A fleet of sleek new trucks collects recyclables around the city.

Garbage In, Resources Out

Early recyclers learned the hard way that thousands of households won't necessarily provide the clean, uniform product that manufacturers can use. Some people will throw away half-full jars of mayonnaise and marmalade, while others will scrupulously wash and dry their bottles and cans, removing the labels and squashing the tin cans flat. "A glass mill can't decide to use cullet [ground glass] over raw materials if it doesn't know what the quality of the glass will be, whether or not it will be contaminated by ceramic material or stones," says Schall.

The Wilton center uses a labor-intensive approach to ensure the quality of its recyclables: workers comb through the collection bins before pushing the materials into storage bunkers. Director Moore says that the staff learned not to overwhelm people with attention. "At first there was one attendant per category. But some people felt badgered. The attendants were idealistic and wanted everything right. You have to be careful when you're changing people's long-time habits—it's not done easily."

Workers at the center compress the cans and paper into tight waist-high blocks with a vintage 1921 chain-driven baler. Glass and plastic are stockpiled. The glass is first crushed by a tractor to reduce its volume, and the PET bottles and jugs are fed into a granulator that chews them into fingernail-sized bits. Most of these materials are used

PHOTOS: NEW YORK DEPARTMENT OF SANITATION

Encore picks up wine bottles, Many Happy Returns buys back materials, and Zoo Doo recycles manure as compost.

by industries in the region.

A higher-tech approach—but one that is still fairly simple—is key to the success of recycling in Camden County. In a matter of minutes, machinery at the Camden Recycling Facility sorts, crushes, cleans, and flattens recyclables into a form that manufacturers can use. The technology was developed by Peter Karter, formerly a civil engineer in the nuclear industry, who guards the details of his proprietary process carefully.

The facility is located on the site of an old scrap dealer. Outside the main building sit several neat 10-foot piles of color-coded cullet and crumpled aluminum. Trucks deliver loads of glass and metal throughout the day.

Inside the building workers wear ear plugs for protection against the din. Unsorted glass and metal travel up a long conveyor as a worker picks out toasters, wire hangers, pots, aerosal cans, paper bags, and other materials that don't belong. At the top of the belt a magnetic separator pulls out tin-plated steel cans and sends them to a processor that cleans and flattens them. The lightweight aluminum cans are blown into another processor and crushed into tight balls. The glass continues along the conveyor past workers who separate it by color—clear, brown, green. The bottles fall through vertical crushers into rotating sieves called trommels, which sift out labels and errant remnants of food. Along with other remaining garbage—about 10 to 15 percent of the original load—this refuse is landfilled.

Workers at the Camden Recycling Facility in New Jersey sort glass bottles by color, which are then crushed.

Karter calls the recyclables raw materials that he mines. He sells the ground cullet to glass manufacturers in New Jersey and Massachusetts. Reynolds Aluminum, which provided the crusher for aluminum cans, buys the tight wads the machinery ejects for a plant in Hartford, Conn. The tin cans go to a plant in Baltimore that removes the tin plate from its steel base. Although tin cans are not recycled nearly as actively as aluminum, they still draw customers. Cans provide the only domestic source of tin in the United States; the steel also is valuable because of its high quality and consistent composition.

When the Camden Recycling Facility first opened in April 1986, only about 6 towns brought their recyclables there. By last March, when it reached its expected level of 40 tons per day (half its capacity), the number of towns had also climbed to about 40. The towns use the facility for free. If they set up efficient collection systems that cost less than the tipping fees they avoid, they can end up paying less for garbage overall. As the volume produced by the plant builds, the towns will also share profits from its sales.

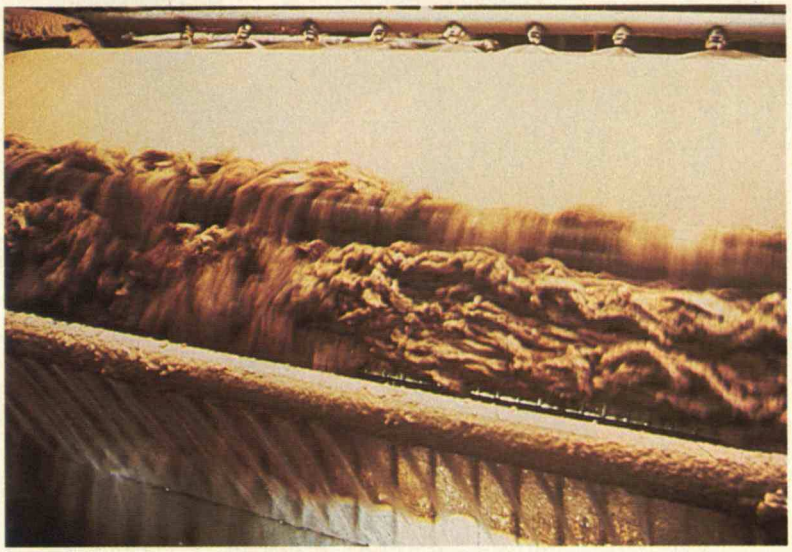
Processing plants are a key part of the new wave of recycling. Massachusetts, New York, and several other states are planning to build regional facilities. By readying secondary materials for manufacturing, such technology makes large-scale recycling possible. The central facility provides a direct link between recycling in the home and recycling at the factory, fostering participation at the one end and demand for materials at the other.

To Market, To Market

One of the strengths of today's recycling enterprises is their intent to forge long-term links with industry. The Wilton program originally had trouble finding markets because of its size, and sometimes had to stockpile paper and glass. Now the New Hampshire Resource Recovery Association, a private nonprofit group that assists recycling efforts, coordinates the sale of most materials. Similarly, central processing facilities often do their own marketing, removing that burden from the public sector and individual programs.

If offered a steady supply of good products, industry can use recycled and processed materials in place of their virgin counterparts, and often advantageously. Cullet can replace some or all of the sand, soda ash, and limestone a mill ordinarily uses to make glass. Before energy prices shot up in 1973, manufacturers generally used just 15 to 20 percent cullet. Some mills will now use 80 to 90 percent if it is clean and free of contaminants. Because it melts at lower temperatures than

PHOTO: SUPPLIED BY JOHN R. PURVES



the raw materials, cullet saves wear and tear on the melting tank and uses less energy. It also lowers emissions from the furnaces.

The most active advocates of aluminum recycling are its manufacturers: they use 95 percent less energy to recycle aluminum than to smelt it from bauxite ore. Reynolds and Alcoa promote recycling throughout the country and support existing bottle bills. Last year Alcoa alone recycled 550 million pounds of aluminum, and more than half of the 300 billion aluminum beverage cans purchased since 1981 have been reclaimed. According to the Worldwatch Institute, on average a recycled aluminum can is back on a supermarket shelf in six weeks.

Unlike glass and aluminum, paper cannot be recycled indefinitely—eventually the fibers break down. But many grades of paper can be de-inked, cleaned, and bleached, processes that require less energy and water than those used to create virgin pulp. The recycled material is used to make products such as gameboards, cereal boxes, covers for hardcover books, ticket stubs, and tissue paper.

There is a sizable demand for waste paper. About 200 of the approximately 600 U.S. paper mills use waste paper exclusively, and another 300 use 10 to 30 percent. Rod Edwards of the American Paper Institute claims that the domestic use of waste paper is expanding. Countries in Europe, Asia, and South America with little timber are also importing growing amounts of waste paper, one of the largest exports from New York Harbor.

Recycled paper still sometimes carries a stigma, says Jeff Coyne of Earthworm, a nonprofit organization in Boston that has recycled office paper since 1970. One of Earthworm's customers uses recyled paper for all its products but one—surgical gowns. The customer worries that gowns made from waste paper might be seen as less than sterile.

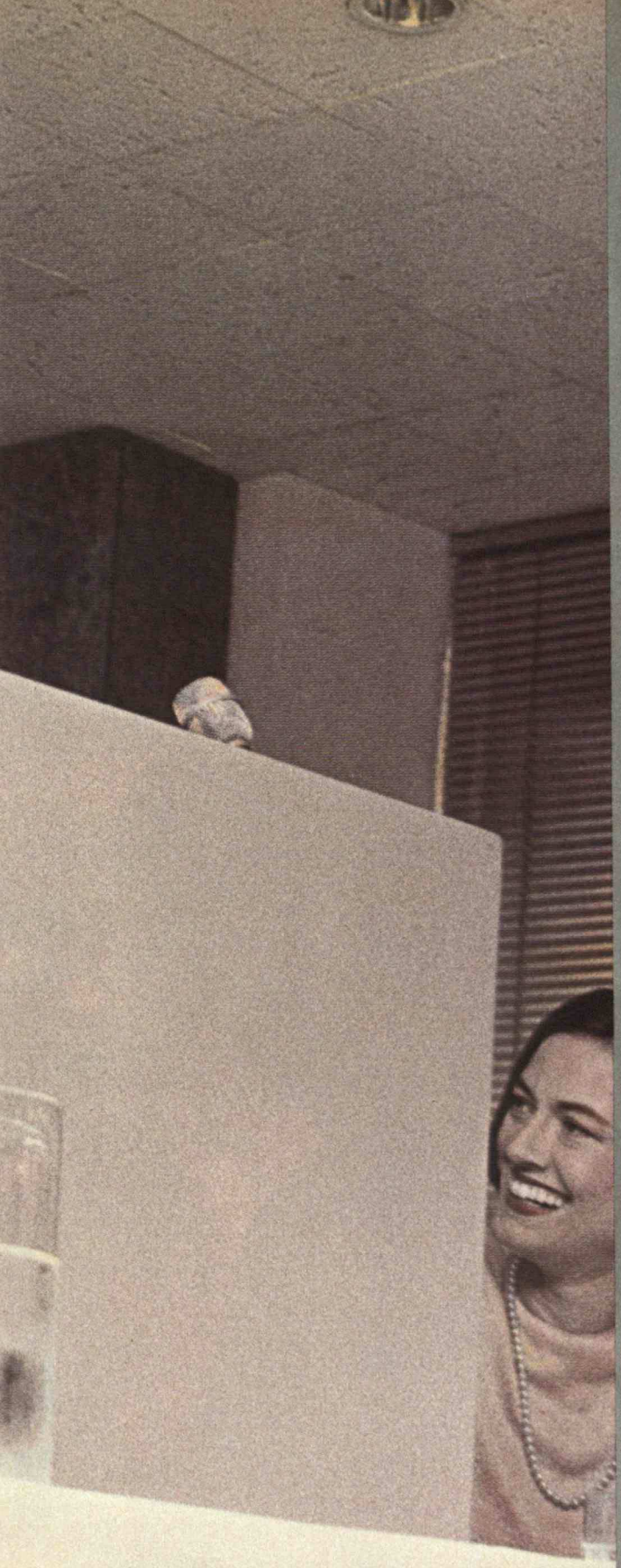
Securing markets for secondary materials wins just part of the battle, because the prices they command fluctuate with changes in foreign demand and the overall state of the U.S. economy. A growing economy boosts demand and thus prices. Construction contractors, for example, begin to need more plasterboard, which is faced with waste paper. Consumers also buy more pizza in boxes, more shoes in boxes, more stationery, more books. But when the economy drops into a recession and exports fall, the price also falls. Recyclers must be able to survive such roller-coaster prices.

Opinions vary on whether an increase in recycling and processing facilities will flood the markets, driving down the price for secondary materials. In New York, which produces 25,000 tons of garbage a day, public officials worry about just such a problem. But Massachusetts' Schall insists that markets for reclaimed glass, steel, and aluminum "will

Continued on page 71

After collection, waste paper is pulped for manufacture into new products. Bales of old corrugated cartons are reused throughout the world, especially by nations with a shortage of timber.

PHOTO: *RESOURCE RECYCLING*



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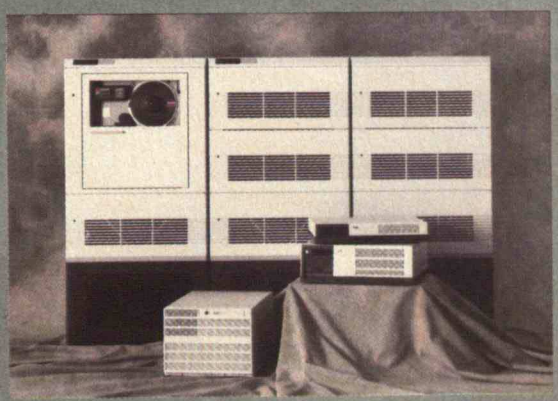

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The Next OIL CRISIS

BY MICHAEL LYNCH

THE oil crises of the 1970s taught most Americans vivid lessons: The world has limited reserves of fossil fuels, especially oil, which will run out before long. To make the most of existing supplies, we should increase the energy efficiency of buildings, vehicles, and industry. And since foreign importers can cut supply lines at any time, the United States should develop alternative sources of energy as quickly as possible.

These lessons were largely wrong. Our energy needs will not be threatened over the next few decades. For stationary applications such as generating electricity, running industries, and heating buildings, we can use coal and natural gas. These fuels are abundant the world over at prices equivalent to $30 a barrel of oil.

For transportation we need liquid fuels, which are easier to handle and concentrate more energy in

New oil crises could occur any time. To reduce their impact, we must understand the real causes of past ones.

PHOTOGRAPH: JIM ANDERSON, BLACK STAR

In 1979 a drop of only 11.5 percent in the world oil supply caused petroleum prices to triple.

less volume. These fuels are also available at prices of $30 a barrel. The world's proven oil reserves total 700 billion barrels—more than 30 times current annual consumption. And these figures assume that drilling will not uncover new oil. In fact, even though 200 billion barrels have been produced worldwide in the last decade, there are more known oil reserves now than there were 10 years ago. This increase is partly due to new technologies. For example, three-dimensional computer imaging has improved seismic analysis for oil exploration. Horizontal drilling techniques have increased recovery from oil fields, and the use of floating platforms or ice islands has reduced ocean drilling costs.

Moreover, responses to the oil crises of the 1970s have reduced consumption, thus prolonging access to this resource. Perhaps the most important factor has been conservation. On a world scale, more than 10 million barrels of oil a day have been saved relative to the consumption levels of 1973. In the United States, more than 5 million barrels per day have been saved. In addition, the developed nations have provided an important "source" of oil by switching to coal for generating electricity. Refineries have been able to increase their output of gasoline and other transportation fuels, thereby producing as much as if they had refined an additional 6 million barrels of oil a day. If the rest of the world follows suit, gasoline production could rise 70 percent, enough to supply most transportation needs for the next 20 years without requiring an increase in oil production.

However, there is still reason for concern about oil supplies. Oil crises are caused not by dwindling reserves but by supply interruptions, many of which are relatively minor. For example, the Iranian oil crisis in 1979 involved a loss of only 11.5 percent of world oil for four months. Yet this resulted in a tripling of oil prices, forced the United States to send an additional $35 billion a year overseas for oil, and helped initiate a major recession. There was panic among oil companies and consumers—ranging from large industries to individual drivers and homeowners. They increased their inventories, whether in gas tanks or large storage tanks, and bid up prices.

The failure to understand that energy crises involve such short-term interruptions sometimes led to inappropriate actions. For example, policymakers supported attempts to develop alternative energies such as solar, wind, and wave power; alcohol fuel; and coal gasification and liquefaction. But their viability depended on declining oil reserves and rising prices. A peak of $34 a barrel in the early 1980s doomed widespread application of most alternative energy sources. The price crash of 1986, when oil fell to $10 a barrel, dealt the final blow.

The United States has taken some measures to help avert or temper a future oil crisis. One of the most useful has been spending $15 billion to fill the Strategic Petroleum Reserve (SPR). Delivering its oil could prevent or defuse some crises and slow price increases in others. However, unless U.S. leaders understand the factors behind oil crises, they will not use the SPR or other measures effectively.

What Is an Oil Crisis?

There are two main types of oil disruption. Technical disruptions are the more prevalent, while political disruptions are more serious. The first type occurs when something stops the normal production, transportation, and distribution of petroleum, such as a pipeline break or a refinery fire. Because technical disruptions have straightforward solutions, "panic" purchases are minimal.

The Suez Canal crisis of 1956 can be considered a large technical disruption. Of course, the instigation was political. When Egyptian President Gamal Nasser nationalized the canal, the French and British invaded in conjunction with the Israelis, so tankers had to be routed around the Cape of Good Hope. This meant that no oil reached Europe from the Persian Gulf for two weeks. Gasoline lines formed throughout Europe, and oil prices rose 30 percent worldwide. However, there was a ready technical solution. The oil companies chartered additional tankers and restored Persian Gulf supplies. Over the course of a year, prices returned to their previous level.

In contrast, a political disruption such as an embargo can last indefinitely, so rationing to stretch oil supplies must assume the worst. The impact will go beyond the actual size of the oil cutoff, as supplies are pulled off the market for possible future needs.

Sometimes producers shut off oil supplies in a deliberate attack on consumers. In the Arab oil embargo of 1973, a group of exporters sought to use oil to pressure Western nations to force Israel back

MICHAEL LYNCH is a research associate with the International Energy Studies Program at the M.I.T. Energy Laboratory, where he works on issues of oil and gas markets and energy and security.

PHOTOS: BETTMANN NEWS PHOTOS

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October, 1987

To M.I.T. Students,

TECHNOLOGY REVIEW is one of the major services of the Alumni Association to the Insitute and its graduates, and as we look forward to welcoming you into the Association's fellowship, we are pleased to share the magazine with you. You'll receive four issues of the REVIEW, of which this is the first, during the 1987-88 academic year.

TECHNOLOGY REVIEW is a nationally circulated magazine, published by the Association, that emphasizes the implications of technological change and reflects in many ways M.I.T.'s activities and influence. The REVIEW also keeps alumni current on Institute affairs and brings them news of their classmates and fellow-alumni. I know you will enjoy the REVIEW and believe its reports of alumni and their activities will interest you.

In addition to the REVIEW, the Alumni Association provides a variety of ways for M.I.T. graduates to maintain links with the Institute and with each other. Ninety clubs in the United States and around the world provide a network for alumni to keep in touch and to be kept abreast of technical and other developments at M.I.T. Many cities present the Association-sponsored Enterprise Forum to assist entrepreneurs through expert analysis of their business plans and activities. Technology Day, the National Alumni Conferences, class reunions, and departmental programs all enable alumni to benefit from a continuing relationship with the broader M.I.T. community. Some alumni work with the Alumni Fund or serve as Educational Counselors, thereby enjoying the friendship of fellow alumni as well as supporting the Institute directly.

As President of the Alumni Association this year, I commend you on your perseverence in your studies, congratulate you in advance on the reception of your degree, welcome you to the Association and urge you to participate in our activities. The Alumni Center (Room 10-110) and the New York Center on the seventh floor at 341 Madison Avenue open their doors to you.

Very sincerely,

Raymond S. Stata

Raymond S. Stata
President

RSS:sasj

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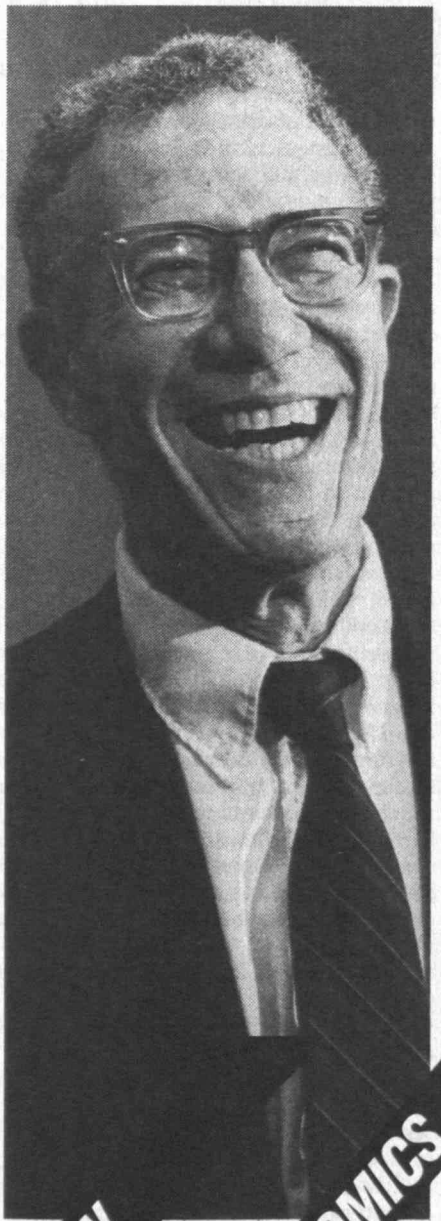
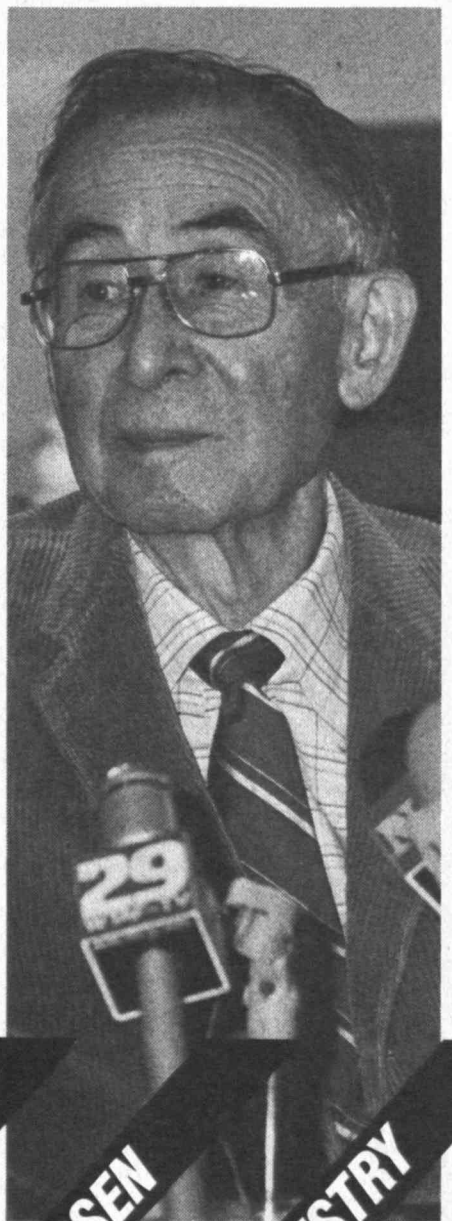
THREE NOBEL PRIZE WINNERS



SOLOW IN ECONOMICS

TONEGAWA IN MEDICINE



PEDERSEN IN CHEMISTRY

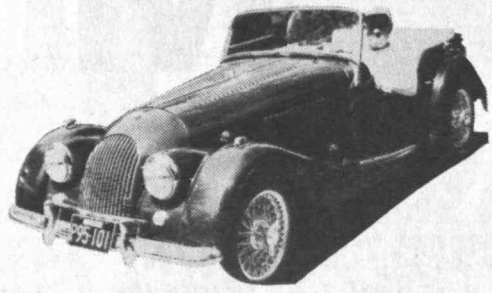
MIT

NOVEMBER/DECEMBER 1987

ABOUT THE COVER

As the printing plates were being prepared for the current edition of* Technology Review, *Nobel Prizes were announced for three members of the M.I.T. community—two faculty members and an alumnus holding a master's degree. Our report must wait until January, but at least our cover celebration is more timely.
(Photos: Donna Coveny, L. Barry Heatherington)

LETTERS
TO THE EDITOR



HITCHHIKER'S LECTURE

The notice of Professor C. Stark Draper's death (*see page 43*) reminds me of my one (accidental) meeting with him in 1965. I was a new graduate student in biology living in Central Square, and I commuted by hitchhiking every morning—not such a dumb thing for a girl to do then as it might be now. One morning I was offered a ride in a rickety vintage sports car, something that looked like a Morgan, with the top down. The driver was a man in his 60s, wearing a sporty, peaked jockey cap. I got in anyway. He identified himself as a professor at M.I.T. who didn't approve of hitchhiking and usually wouldn't pick anyone up on principle. He wanted to give me a ride so that nothing would happen to me, at least on that day.

I only learned how famous was my chauffeur after he had dropped me off in front of the Institute. A classmate ran up and exictedly told me, "*That* was Stark Draper!"

HANNAH FRIEDMAN ELSON, Ph.D.'70
Bethesda, Md.

TWICE PICTURED

You may wish to note that the painting above Helen St. Laurent's head in the photograph in the October issue (*page MIT 64*) was painted by a professional artist, Maxine M. Clarke. Maxine has her own close ties to the late Raymond St. Laurent's M.I.T. class. The picture was done from a series of photographs I had taken, and Maxine and I presented it as a surprise gift to Helen and Ray during a luncheon of the Class of 1921 at its 50th reunion.

CAROLE A. CLARKE, '21
Brielle, N.J.

FOREIGN STUDENTS AS MINORITIES

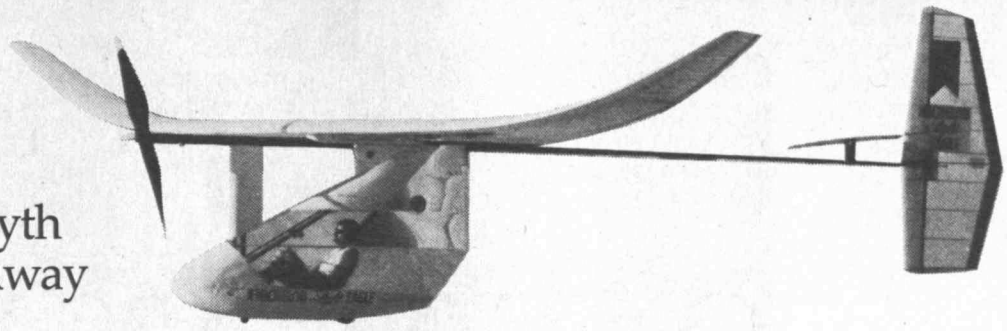
I read with interest the report on "Race Relations on Campus: The Problem, Some Solutions" (*May/June, page MIT 4*). While I do not doubt the earnestness with which efforts are being made to solve the problems of minority groups, I could not help feeling that a major factor is being underemphasized—a factor that also applies in the case of foreign students.

As a foreign student at M.I.T. in 1950-51 I was very much aware of the cultural differences between American students and foreigners, which put the foreign students at a disadvantage in coping with the courses and teaching methods. If a study of foreign students' performance at M.I.T. does not confirm this disadvantage, I believe that is due only to the special treatment that foreign students have typically enjoyed at the Institute. My case is an example: my first awareness of special assistance was through a letter from another South African already at M.I.T. that gave me much useful information about what to expect and how to make a good start. In addition, I was advised to do an intensive summer program in order to help me overcome any disadvantage; I am forever grateful to the late Professor Walter G. Whitman, '17, for his guidance.

I feel that some of the steps presently being contemplated, such as trying to increase the number of minority students, are unlikely to improve their performance. The increase in minority students is likely, in fact, to increase the number of students who may have difficulties and reduce the help that faculty can give to any one of them. A better alternative is a more specific treatment of the existing problem, such as a special summer program to help give minority students a head start and become oriented to a rather bewildering new environment. This may even lead to better-than-average performance by minorities, which could solve a whole range of problems, including both low levels of self-confidence and the disparaging remarks from those without similar disadvantages.

Cultural disadvantage must be calculated as the major problem of minorities at M.I.T. We cannot fall back on racialistic notions of heredity and genetics to explain minority underachievement.

PAUL N. MALHERBE, S.M.'51
Constantia, South Africa



Reenacting a Myth Only Months Away

With $430,000 from its major sponsor, United Technologies Corp., M.I.T.'s Daedalus human-powered aircraft project is rapidly approaching its next major checkpoint: roll-out and test of a new, advanced plane for which last year's record-breaking *"Light Eagle"* (*see April, page MIT 9*) was but a prototype.

The new plane, to be christened *"Daedalus,"* is designed to make the 70-mile crossing from Crete to mainland Greece, perhaps as early as March, to symbolically recreate the flight to freedom of its mythical namesake.

The *"Light Eagle"* holds the current world distance record—a flight of 37.2 miles in January 1987 with triathlete Glenn Tremml as pilot. Three world records for speed and distance by a woman pilot were also set by Lois McCallin in *"Light Eagle"* last January at Edwards Air Force Base in California. (Both pilots remain with the team.)

But even after these remarkable performances, an over-water flight of 70 miles is an intimidating challenge. So the Daedalus team, some 25 full-time workers—alumni, faculty, and students—augmented for the summer by nearly 15 M.I.T. undergraduates working under the auspices of the Undergraduate Research Opportunities Program (UROP), has spent the last eight months in painstaking design and construction of a new plane.

Chip off the Old Block

In physical dimensions and appearance *"Daedalus"* will be much like *"Light Eagle"*—a tiny cocoon carried by a gossamer-light wing that extends 112 feet from tip to tip, pulled by an 11-foot propeller that turns only about 120 revolutions per minute in cruising flight. But *"Daedalus"* will be a breed apart, says John S. Langford, '79, project manager—a unique aircraft especially designed for endurance flying.

Every piece of *"Light Eagle"* has been restudied and its counterpart in *"Daedalus"* refined. There has been a "painstaking reduction of the weight of all the components of the aircraft, gram by gram," says a report to the American Institute of Aeronautics and Astronautics. For example, a new foam material for the wingtips cuts a few ounces while offering a slightly finer texture that will yield better aerodynamic performance. A stronger graphite unavailable for the "Light Eagle" is used throughout.

The result of this redesign is that *"Daedalus"* will weigh only 70 pounds, compared with *"Light Eagle"* at 90. This reduction of 20 to 25 percent in weight will reduce by 10 to 15 percent the power required for level flight. As a system for long-distance human-powered flight, *"Daedalus"* may be as much as twice as efficient as *"Light Eagle."*

It's an achievement that would have been impossible without *"Light Eagle"* as a prototype, says Langford. *"Daedalus"* has been "a uniquely effective demonstration of the process of engineering design," he says. "It displays every engineering trade-off on a scale that can be experienced by all of us."

As *"Daedalus"* neared completion, the logistical problems of the Crete-to-Greece flight came in for increasing attention. Supporting an over-water flight in a foreign country will be "100 times more complicated in terms of being prepared for problems" than the flights over Rogers Dry Lake in California, says Langford. Already the Daedalus project has a full-time staffer operating an office in Athens, where back-up pilots have been selected from among members of the Greek National Cycling Team.

After display at the Smithsonian Institution in Washington, D.C. in the spring and early summer, *"Light Eagle"* was returned to Cambridge in midsummer. Late in August there was a spectacular dawn flight over Block Island Sound, off Charleston, R.I. It was the first over-water flight for *"Light Eagle,"* and Langford admits that one of the purposes was to stimulate the team and gain a new round of public interest; fundraising is not complete, despite the major United Technologies grant.

But there were also tough questions to be answered about logistics and about the pilot's psychological response to flying over water instead of land. The result was a significant discovery:

Given the windless condition that is sought for human-powered flights, the water is likely to be mirror-smooth. So the pilot lacks the visual clues of the aircraft's altitude that are available when over land. When over water, Tremml found that *"Light Eagle"* could easily be flown too high—or too low. Solution: one boat, producing minimum wake so as not to disturb the ground effects on which *"Daedalus"* will want to capitalize, has to be positioned ahead of the aircraft, in the pilot's range of view.

There is an eight-week "window" of good weather, starting in mid-March, when the required conditions—1- to 5-mph winds and temperatures between 30° and 50°F—are likely in the eastern Mediterranean.

Innovation in Fact and Spirit

"Light Eagle" provided a platform for testing a new strategy for aerodynamic design of wings developed by Professor Mark Drela, '82, of the Daedalus team—a "very significant" contribution, says Langford. *"Light Eagle"* is the largest all-composite aircraft ever built, and its use of these materials is at the cutting edge of this technology.

In these and other ways, says Langford, Daedalus will contribute to the design of future U.S. aircraft for low-fuel-consumption, high-altitude flight.

But Daedalus' greatest contribution may well be like that of the *"Voyager"* round-the-world non-stop flight in 1986—a popular affirmation that the spirit of exploration and innovation that is associated with American technology is alive and well. No project at M.I.T. in recent years has so drawn the popular media. Photographers for the *National Geographic* are regular Daedalus visitors. And Peter Parks of Long Island's *Newsday* waited through four days of bad weather to see the Rhode Island flight of the *"Light Eagle"* in August. "Poetry in motion . . . breathtaking," Parks wrote.—*John Mattill* □

PHOTO: AP/WIDE WORLD

ASSESSMENT AND CHANGE IN UNDERGRADUATE EDUCATION

ONE MAN'S VIEW:

The Dean of the School of Engineering Speaks His Mind

Gerald L. Wilson, '61
interviewed by
Technology Review
Editor
Susan Lewis

TECHNOLOGY REVIEW: As dean of M.I.T's largest school and a faculty member in its largest department [Electrical Engineering and Computer Science], holding all of your degrees from M.I.T., you could surely be described as being in the Institute's mainstream. It seems significant, then, that you are cited around the campus as one of the most impassioned proponents of review and change in the undergraduate program. Why is the process so important for engineering?

WILSON: In the course of an engineering career, it's easy for one to get caught up in the technology, almost in technology for its own sake. That's what attracts most engineers—the excitement of building something useful that is at the same time fun to conceive, design, build, and see working.

I know when I was a student, then a faculty member, I didn't want to be bothered with the fuzzy features of the rest of life. It was more interesting and challenging to excel and interact with technology in a deep way, to be precise and rigorous on hard problems where the bounds and constraints were very clear. That's what is respected in the engineering culture.

But as they move on in their careers, some engineers grow to realize that if they want to exercise leadership, if they want to have a substantial positive effect on society, they must become much more effective at understanding what society wants and what it can use in a broad context.

That requires an about-face for many engineers. There's almost an arrogance on the part of engineers—and I include myself here. We believe that we know better what can be done technologically and what the customer really *should* want, in contrast to what the customer or the broader society does want.

The average engineer seems to have a hard time learning that an essential part of success is the acceptance of a technological product or a solution by the individuals who are supposed to benefit from it. That usually means acceptance by people who do not understand technology, who are therefore frightened by it, but who still have valid concerns.

Those concerns then become the basis for regulations and socially imposed constraints on the functioning of technology. Society is trying to protect itself from us.

The new social constraints may be imprecise and fuzzy, but they are just as real as the technological constraints engineers are accustomed to. If we as engineers don't listen to and develop an understanding of society's concerns and then address them in creative ways, we'll find ourselves prevented from exploring and using technology. That is a point we haven't been making clearly enough to our undergraduate students.

PHOTOS: NINA TOVISH

Right now M.I.T.'s required curriculum in the engineering disciplines contains almost nothing about the interaction of society and technology, so the implication is: it's not important. That's the first thing to change.

I'm really concerned that if M.I.T. doesn't take the lead in understanding the broad issues related to technology, some other institution will, and we'll become second-rate very fast.

TR: You say that as a student and faculty member, you were totally caught up in the rigor of technology. What changed your focus?

WILSON: I was bumped downstairs—to the dean's office. I have noticed that many deans have come into this position as normal engineers, and after two or three years they're talking about all these soft societal issues. As a faculty member, I was suspicious that there was a mysterious gas that's bled into the dean's office that changed his thinking! But in fact, sitting in this position, I began to see how much more technology could do for society if we as engineers took a stronger role in helping society understand the technology and understand what bounds should be placed on it.

TR: Could you give an example?

WILSON: The area of applying technology in medicine is not explored as well as it could be. There's a variety of reasons for that: one is probably the arrogance of both doctors and engineers in terms of their unwillingness to try to communicate with each other. But it is also true that the rules for introducing technology into medicine have been formulated by Congress or other bodies that are primarily composed of lawyers who don't understand technology.

Engineers have disdained to become involved in the process of regulation. It almost makes them ill to get involved in those poorly defined, emotionally charged issues in which non-technologists have a central role in making policy that affects technology. Instead, we tend to criticize the stupidity of some of the constraints that society has placed on our ability to inject technology into medical care.

My dream is that one day engineers and scientists will play as much of a leadership role in deciding what limits are placed on technology as lawyers do now.

TR: What is it about the work of a dean that gave you that set of priorities?

WILSON: In this position, I interact more often with people outside M.I.T. who are running their own companies or who are responsible for decisions that have an impact on society. I hear a lot of their frustrations. Many of the issues in which they are involved—such as how we handle waste, how we make decisions about future power supplies, how we handle the location of chemical processing plants and the attendant risk for society—are issues

My dream is that one day engineers will play as much of a leadership role in forming technology policy as lawyers do now.

We laugh at the garbage barge floating around at sea, but it highlights a serious problem.

for which they don't have answers, just problems.

Engineers like to be problem-solvers, and I'm no exception. When I hear about these challenges, it makes me wonder why they haven't been solved.

Why have we failed so miserably, for example, with the Seabrook [N.H.] nuclear plant? [Seabrook is ready to go on line, but the operating license is being blocked by Massachusetts over the issue of safe evacuation plans.] Why have the state and the utility made a $4.5 billion investment, spent public and private funds, and *now* there is a public debate about whether we want the plant or not? In fact, we engineers believed that society had already asked that question through the regulatory process; we thought we had the go-ahead. But maybe, as engineers, we weren't listening carefully enough. The fact that should have been obvious is that the public is very concerned about the safety of a nuclear power plant.

At one of the local town meetings about Seabrook, an engineer stood up and asked, "How many of you who are opposed to Seabrook have bothered to go through the plant and see how it is constructed?" Now what is the average citizen supposed to learn by being taken on a tour of the Seabrook plant? Clearly, the engineer is not talking their language, so there's no communication.

TR: Does the fault lie entirely with the engineers and planners and their lack of communication with the public?

WILSON: Of course not. One of the things that frustrates engineers is that the public tends to face only part of an issue at any one time. On energy, for example, the people of Massachusetts have said they don't want nuclear power. They also don't want more coal plants or more gas- or oil-fired plants.

But of course we all need electricity, so people embrace technologies like wind and solar, about which they know very little. The latest panacea is that the Canadians will generate electricity and sell it to us. Well, the Canadians will have something to say about their future power supply. And if I were John Sununu ['61, governor of New Hampshire], I'd go to some extremes before anyone built a transmission line through New Hampshire so that electricity could be delivered to Massachusetts from Canada while my state's nuclear plant was sitting there rusting!

There are many examples of public failure to confront the big picture. Right now Massachusetts and New Hampshire have no viable plans for handling waste. No community wants a dump; no one wants sanitation trucks running down their streets; no one wants an incinerator; no one wants a garbage barge unloading in their jurisdiction. We all laugh at the barge floating around at sea trying to dump its load, but it dramatizes a serious point: as a society, we don't have an effective system for making these decisions.

TR: What would it take to change that situation?

WILSON: We need a mechanism for engineers to work with other members of society. On specific issues, representatives of the technical community and society at large need to address their differences and concerns, come to an understanding of the societal priorities and the technical limitations, and develop mutually acceptable policy choices.

That principle of working hard to identify questions and problems *before* proposals are made has rarely been tried. Instead, the public is often forced to react to a specific plan in isolation. Groups mobilize for and against the proposal, all sides bring in experts who provide conflicting testimony, emotions heat up, and ultimately somebody "wins." But are the best long-term interests of society served?

TR: Do you know of situations where the strategy you suggest is being tried?

WILSON: There are people in the hazardous substance management group at M.I.T. — in particular Professor Larry Susskind of the Department of Urban Studies and Planning — who are working on exactly that scenario: how do you take an adversarial situation that centers on a technical or scientific issue and resolve it? They are trying to involve not only engineers, but urban planners, biologists, and chemists—working with industry and community representatives on real problems. I'm hoping they will provide a model we can employ in our teaching.

TR: Is there a particular reason why some engineers are becoming more alert to the broader issues right now?

WILSON: Civil engineers, since they build structures like dams and highways in which there is a high public interest, have always had to work within society's rules. Now the areas of societal control are broadening; the rules are becoming more restrictive and having an impact on the work of chemical engineers and nuclear engineers. Electrical engineers may have thought that they were relatively impervious to public regulation, but the day is not far off when they too will feel it. For example, at one integrated-circuit facility, miscarriages among women employees are occurring at double the national rate. No one understands why. There are people investigating the problem, and their findings will be incorporated in appropriate safeguards.

We could take the position that hazards and regulations are the negative side of technology. But these are new areas where there are a lot of unanswered questions, areas where engineers in general and M.I.T. in particular can explore and contribute solutions.

TR: Isn't that going to require a change in the attitude of engineers toward direct involvement in political activities?

WILSON: I believe that's true. We certainly have to attract students who are willing to become personally involved. But more to the point, we have to expose students to a faculty that understands how important it is for engineers to take an active interest in politically charged issues. That will require a big change. I think the students are greatly influenced by the way the faculty behave, by the way faculty spend their time. Most of our faculty spend their time on technology, and rightfully so. That is the message they've been hearing for decades; that's what they are rewarded for. And if they do participate in forming public policy, they do it by testifying in Washington or elsewhere away from campus. As a result, students don't share in policy-related activities and aren't aware that faculty members value such activity.

TR: But under the present scheme of things, the policies are still made by Congressmen and bureaucrats who may or may not chose to heed the advice of engineers and scientists.

WILSON: Right now they are. But that could change, and it should. The first step is to educate people who can articulate the technological position and who really understand how that position will be perceived by folks on the other side of the fence. That will be difficult, but the need is clear.

TR: How widely are your concerns shared among faculty in the School of Engineering?

WILSON: I think that many of the faculty are frustrated by society's meddling with technology and by the constraints society puts in place. I also think there are many faculty in the school who are aware that these constraints are real, that they represent real issues. But I don't think faculty know how to deal with them, although some are trying to learn.

The School of Engineering conducted a survey asking faculty to rank the 10 goals for an undergraduate engineering education (*see October, page MIT 23*). One of these goals was to instill in the students a deeper understanding of the effects of technology on society, and a second was to try to intensify their involvement in the liberal arts. Most of the faculty who voted ranked these goals near the top with respect to importance, but at the bottom with respect to how well we are implementing them in our present program. I think that is a realistic attitude.

TR: M.I.T. has invented new curricula before. Is anything stopping us from doing it again?

WILSON: The difficulty the faculty sees, and I see the same difficulty, is that M.I.T. has always prided itself on teaching principles, teaching fundamentals. We don't just *train* people to do things the way they are done today; we try to give them a deeper understanding, so that they are prepared for a lifetime involvement in technological change. But how do you teach students to deal with the social issues surrounding the use of technology? Are there principles that govern political and societal situations involving technology?

Classes on these topics usually wind up with somebody telling war stories—case studies, that sort of thing. Our students are spending some stunning amount per hour to sit and listen. They shouldn't be getting pap; they should be getting the beef. So the faculty is very hesitant to offer subjects in which teachers may only be able to tell war stories. But we may have to use case

The new social constraints may be fuzzy, but they are as real as the technological constraints that engineers are accustomed to.

If M.I.T. does not learn how to create this new engineer, we could become second rate very fast.

study methods for the short term, to enable us to learn what it is we should be teaching, what the principles are, for the long term. We have to start somewhere.

TR: There are academics working in this area, and M.I.T.'s program in Science, Technology and Society (STS) has been offering classes since 1977.

WILSON: True. But it's dangerous turf. People who focus on societal questions are thought by many of their colleagues to be getting soft; they've stopped worrying about good, hard technology. And it's not just a question of intellectual snobbery. This is a difficult area in which to get results. You ask someone who's been studying these issues for 20 years what they have accomplished, and they don't know. They know it is important, but they still can't identify the principles.

People used to say that faculty who work at the interface of society and technology aren't recognized. I think we have improved in terms of promotion and so on, but it still requires unusual commitment and courage for a young faculty member to pursue his or her concerns in this area.

This is as much a result of our inexperience in evaluating this type of work as our unwillingness to reward it. Scientists are very good at ranking; they can rank each other within microsteps, because science is a very precise business. When you start talking about engineering design, however, aesthetics enter the picture, and it becomes harder to rank designers. And when you examine engineers who are working with societal issues, who are looking at open-ended, fuzzy constraints on engineering, it is almost impossible to set criteria for achievement.

We must do more to to ensure that scholars in this area are respected by their colleagues. We must recognize that this work is difficult. If we did nothing else, that would help the situation.

TR: Is this really what undergraduate change is all about in the School of Engineering?

WILSON: Only in part. The school also has to deal with the rate at which technology is changing and with new technologies for learning. We wanted to review our whole undergraduate program and environment and look for opportunities to make significant improvements.

It's always been our objective to distill and codify information and new techniques into a set of intellectual principles and methods for our students to learn. But technology is changing rapidly, and without care and time to think through what we teach, the natural tendency is to pass on more information, more facts. That soon becomes a training process, not an educational process. Periodically, we have to take time to ask what are the fundamentals? How can they best be taught—can we use delivery methods other than a lecturer in a classroom?

We want to look at the relationships that develop between faculty and students. Student life in the classroom and student life in the residences seem to be separate worlds; can we break down the barriers between them? How can we broaden the perspective of our students—prepare them for an even more challenging world of technology?

TR: Who decides what the next steps will be?

WILSON: Not the deans, I can tell you. My job is to attract the brightest people in the world, both faculty and students, to this institution and to this school, to understand what the faculty think are the right choices for the future, and then clear the way, make sure that what the faculty thinks should happen, *does* happen.

There are times when I believe this job gives me a perspective that the average faculty member may not have, so I suggest changes I think we should put in place. I keep posing questions about what we are doing. I cajole, encourage, cry, drop ideas around, try to get people together to think and talk about issues. But the minute I give orders, you can be sure that's what won't happen! I don't think I could get a closet painted the color I wanted around here. The faculty make the decisions on education and research issues; that's the way it should be.

TR: I have heard faculty members say that they need more subjects in their degree programs just to maintain their engineering accreditation. What happens if we have to add classes to address societal issues?

WILSON: We don't know yet what kind

of impact these new ideas will have on the number and nature of subjects we offer our students. Our strategy will be to first try to understand the right way for engineering education to go, independent of any external accreditation organizations. And second, when we make changes, we will try to convince these organizations that we're right.

Debates with the rulemaking agencies are not new for M.I.T. Every time there is a site visit by the Accreditation Board for Engineering and Technology (ABET) we run into a buzz saw of objections to our undergraduate program. For example, ABET requires the equivalent of two subjects in design. We don't have two subjects labeled "design" in every engineering degree program, but we have many subjects where students are exposed to design. So we have to take a lot of time to demonstrate to ABET that there is a design component to our degree programs.

We've had a couple of occasions when M.I.T. engineering departments have been told that their accreditation will be reviewed in two years rather than five because ABET wasn't comfortable with what it saw. So far, we've always been able to make the case for accrediting our programs. But in the final analysis, M.I.T. has to offer a program *we* believe in.

TR: How do alumni fit into the process of undergraduate change?

WILSON: We get relatively little feedback from alumni, other than through visiting committees. What reaction we do receive to the idea of making our curricula more responsive to large societal concerns is of two kinds. Some alumni say it's about time we addressed some of these issues; they welcome change. Others are concerned that we're going to take an institution that really understood what its goals are, that excelled in science and technology, and allow it to become soft and mushy. They fear that we'll become second-rate.

TR: I hear those concerns, too. How do you respond to such criticism?

WILSON: I remind them that the Institute has often applied its strength in science and technology to areas that were considered somewhat fuzzy, and helped to redefine those fields. Linguistics, psychology, economics—we were instrumental in making them more quantifiable sciences. M.I.T. brings in researchers who are disciplined, who work at making models that will enable them to understand a subject in depth and test that understanding in a scientific way. In so doing, we helped strengthen and solidify fields that had been much more ephemeral, in which the principles were once much harder to pin down. I think we can do it again in the area of technology and public policy; and when we do, it will be consistent with M.I.T.'s history of contributing to change and excellence.

TR: Even if you can find space in the curriculum for students to study these broad issues, where will the faculty find the time to develop new materials?

WILSON: That will be a problem. Right now, the faculty are stretched too thin. They are under pressure to find funding for their research and for a portion of their salaries. They don't have adequate time to think and to contemplate; they don't have the kind of technical and teaching support staff that they should have.

There are a variety of things I am trying to do to address those issues, but one of the steps is to trim down the number of faculty while keeping the present level of support in each department. Now it may sound bizarre to help faculty find time by reducing the number of faculty, but I believe that we should narrow our focus in some areas and concentrate resources in others.

I told the departments two years ago that Jack Kerrebrock [associate dean of engineering] and I decided to reduce the number of faculty in the School of Engineering so that the existing Institute funds would allow the faculty to use their time, thought, and creativity much more effectively. It's a very unpopular plan—it's in the opposite direction from the one in which almost everyone else in the school would like to see us moving.

I've watched what happens when we add faculty: we have to find more space, more research funds, more support staff, and of course—to support the research effort of new faculty—more graduate students. In no time, the new faculty member is as overloaded as his or her colleagues, with relatively little time for any but the

If we reduce the number of faculty, we can stretch existing Institute funds to allow faculty to use their time more creatively.

most essential meetings with fellow faculty members or undergraduates.

But suppose we reduce the number of faculty and graduate students while keeping the resources of space and funds in place? Will the quality of faculty life and the faculty contributions to M.I.T. improve? Can we offer faculty a little more time to think about curricula and their visions for the future? I believe so. And I believe we can maintain our stature as a first-rank institution at the same time; our departments all have more faculty than comparable departments at universities with whom we compete, such as Berkeley and Stanford.

As long as we have a commitment from the administration that the resources will not be reduced for each department, I think we can be stronger.

TR: As you say, the number of graduate students supervised and supported by a faculty member is another drain on the time available for undergraduates and contemplation. Are you trying to do something about the recent growth in the graduate school?

WILSON: *Trying* to reduce it, yes. Not very popular. At present, we have at least as many graduate students as undergraduates in the school.

TR: Would you care to put a wrap on this?

WILSON: Some institution must learn how to generate this new engineer, one who will play a part in developing rational policies governing technology; one who won't be a "technological mercenary," solving somebody else's problems, to borrow [Dean for Undergraduate Education] Margaret MacVicar's phrase. It has to be done now. And if M.I.T. doesn't do it, we're going to have a tough time remaining the top engineering school. If we can make some headway on these issues, we'll probably have done more for engineering than any institution will for the next few decades. □

Leadership Counts

As President Paul E. Gray, '54, said in a letter to all alumni, M.I.T. announced the launch of the five-year, $550 million Campaign for the future *on October 22 and 23 at gala events on the Cambridge campus. The November/December edition of* Technology Review *was being assembled as the tuxedos were being pressed, the gowns coming out of zippered bags, and the final touches being put on lectures by nine of the Institute's most promising faculty researchers—aimed at inspiring volunteers and exposing some current M.I.T. achievements to public view. The* Review *will report on all that activity in the January edition. As our own launch of campaign coverage, we offer short profiles of five extraordinary alumni who will provide the volunteer leadership for what President Gray calls "the most ambitious fund drive in our history."*

Cecil H. Green, '23: Philanthropist Extraordinary

The common denominator of the philanthropy of Cecil H. Green, '23, and his late wife, Ida, is their interest in and commitment to *people*—people in need, creative people whose talents can be fulfilled by the Greens' generosity, people who are in a position to leverage other people's potential talents to higher levels of achievement. No wonder, then, that Cecil Green, M.I.T.'s greatest living benefactor, is to be the honorary chairman of the *Campaign for the future.*

The Greens' early lives gave no hint of what was to follow. Cecil came to M.I.T. to study electrical engineering, but he had no well defined career goal. Upon graduation he took a job with General Electric in Schenectady, where he had worked as an M.I.T. student in the cooperative course. There he met and married Ida Flansburgh. For the next decade and more Cecil moved from job to job, coast to coast, with Ida fulfilling her role as homemaker under conditions that were seldom ideal, often frustrating. But frustration was not a word in either Cecil's or Ida's vocabulary, and the experiences cemented their relationship into a lifelong partnership of the closest kind, only terminated a year ago by Ida's death.

Cecil's career began to take shape when he joined a small Texas oil exploration firm, Geophysical Services, Inc., as a party chief in 1930. Green and two colleagues became GSI's owners at the beginning of World War II. As they considered becoming part-owners of GSI, Ida had said that if the company were successful she would be a philanthropist. Cecil shared her concern for people less fortunate than themselves, and he had learned that he most enjoyed working with people on human problems. GSI's success and its subsequent evolution into Texas Instruments, Inc., gave Cecil and Ida the opportunity about which they had dreamed.

Since 1950, writes M.I.T. Professor Robert R. Shrock in a yet-to-be-published biography, 38 years of planned giving have resulted from the Greens' determination "to assist worthy organizations and institutions that are specifically devoted to improving and extending the human potential and to making human existence more pleasant and productive." In sum, the Greens are responsible for 50 academic, medical,

PHOTO: ANTONIS

The success of GSI and its evolution into Texas Instruments gave Cecil and Ida the opportunity about which they had dreamed.

and civic buildings, 28 endowed chairs at 15 institutions, major contributions to scholarships and fellowship funds at nine institutions, and countless other gifts of art and of support for institutional and civic programs.

Cecil had minimal contact with M.I.T. for the first 27 years after graduating. He returned to Cambridge in 1950 at Shrock's suggestion in a quest for well-trained undergraduates to work as summer replacements, perhaps later to join the company permanently. Shrock remembers that at the time some 14 geophysics majors were seeking summer employment in order to earn next fall's tuition money; so a deal was quickly struck. It was the beginning of a warm personal relationship between Green and Shrock and a rewarding renewal of Green's interest and confidence in M.I.T. The students were successful, and that summer marked the start of the GSI Student Cooperative Plan.

Beginning in 1959 there were major donations for the Cecil H. and Ida F. Green Center for the Earth Sciences; endowed chairs in electrical engineering, earth and planetary sciences, education, and physics; career development professorships; fellowships for women graduate students; and the Ida Flansburgh Green Hall. All, says Cecil, result from his and Ida's pride and confidence in M.I.T. and their wish to repay the Institute for its roles in their lives: Cecil's education, the students and alumni it sent to GSI, and the combining of exploration technology with digital signal processing, developed at M.I.T. in the 1950s and exploited by GSI.

At a recent tribute to Green by his fellow alumni in Dallas, President Paul E. Gray, '54, spoke of the Greens' "example of dedicated, enlightened, and inspirational trusteeship (as) a classic example of the best that one could expect or desire from a trustee. There is no university or college president, no hospital or medical school director, no chief executive officer who would not give both arms up to the elbow to have two or three individuals who brought to (his or her institution) the example of stewardship which Cecil has brought to M.I.T. and to those many other institutions that he has served." □

Raymond S. Stata '57: A Bird in the Right Roost

Many M.I.T. graduates have some variation on the "frightening-revelations-from-freshman-year" saga. The episode engraved on the memory of Raymond S. Stata, '57, is associated with the late William W. Buechner, '35, former professor of physics.

"The first exam he gave was a killer," says Stata. "Even if you knew the material cold, you had to do some original thinking on the fly. I think three-quarters of the class flunked. Anyway, when he came back with the exam results, Buechner told his class that "some of you birds are probably in the wrong roost!"

Stata says that though properly intimidated by the experience, he remained persuaded that M.I.T. was right for him. He persevered, earning both S.B. and S.M. degrees in electrical engineering. And in hindsight, he says, he has come to see the kind of pressure that Buechner's exam represented as one of the Institute's strengths.

"There's no question that M.I.T. engenders a certain quality of self-confidence," he says. "You're getting material thrown at you at a very fast pace, and if you can deal with that, you have to feel that you can deal with just about anything that comes your way."

In Stata's case, life's specific major challenge has been building a large company from scratch. He is cofounder and president of Analog Devices, Inc., of Norwood, Mass., a maker of equipment for linking analog information such as temperature, pressure, light and position.

Analog employs about 5,000, its annual sales are more than $350 million, and the market for the company's products has risen at an average of about 20 percent a year. In a 1985 profile, *Fortune* magazine said of Stata that he "really believes—and applies—all those uplifting theories so popular in business schools about taking the long view, creating an informal, democratic culture, and putting the interests of employees and customers ahead of those of stockholders."

Stata says that his managerial approach has been shaped in part by his M.I.T. education—and not least by its humanities component.

"When I went there, I had every expectation of getting a first-rate technical education," he says. "I looked forward to it, I got it, and I wasn't surprised. The thing that was surprising, and I think made an enduring impact on me, was the quality of the humanities education." Stata says the lessons he learned in his humanities classes have helped him deal with such issues as how to create an effective corporate culture.

As his company has grown, Stata has increasingly come to see education as crucial to industrial progress. He has written extensively to warn of a growing shortage of scientists and engineers in this country. He was a founder of the Massachusetts High Technology Council, whose priorities include support for higher education. His company has funded a junior faculty chair and a graduate fellowship at M.I.T. and has given

PHOTO: ANALOG DEVICES

When you look at the figures, you realize that M.I.T. is relatively underfinanced and relies too much on federal funding.

similar support to other institutions.

Stata, a compact man with silver hair and eyes of a penetrating, azure blue, has also committed himself to extensive efforts on M.I.T.'s behalf. He currently serves as 93rd president of the Alumni Association, and he is a member in long standing of the Corporation Development Committee.

These and other commitments spell long hours of involvement in M.I.T. business—hours that Stata must squeeze into a calendar on which open time is already in short supply. He notes that what comes out of his M.I.T. involvement is a greater wisdom and insight about how the world works, which he believes increases his effectiveness as an individual and as the leader of a corporation.

Moreover, Stata says he believes that fulfillment of the goals of the capital campaign is vital to the Institute's future. "A lot of people tend to think that places like M.I.T. and Harvard and Yale don't need any help," he says. "That may be true of some other institutions, but it certainly isn't true of M.I.T. "When you start looking at the ratio of operating expenses to endowment, you find that M.I.T. is a relatively under-financed institution, and that in many ways it's far too dependent on federal research funding," he says. "It should not be surprising that M.I.T. has a need to build its capital base when you consider that it is still relatively young in comparison with other prestigious universities."

He says the forthcoming campaign is not about the Institute's survival as such, but rather about its continued world-class status. That status, he observes, could be in serious jeopardy if federal funding policies were to change. "For an institution that's as valuable as M.I.T. to the region and the country, it just shouldn't be that way." □

Harris Weinstein, '56: No Question, We Always Know How We Are Doing

While an officer of the service fraternity Alpha Phi Omega, Harris Weinstein, '56, had a hand in introducing one of M.I.T.'s more unusual charitable enterprises.

Called the "Ugliest Man on Campus" (UMOC) contest, it permits the students to buy votes (one cent per vote) for their favorite of many competing candidates (now including women as well as men) for the honor of being M.I.T.'s ugliest. The donations go to charity, and the "winner" gains, for his or her effort, whatever notoriety and prestige can be drawn from the achievement.

Weinstein admits that he and his Alpha Phi Omega cohorts have never actually proven that they originated the contest on the M.I.T. campus, but adds, with a grin, "we *claim* we did."

Whatever the facts of the matter, it's clear that this and his other APO activities were but a small beginning of Weinstein's contributions to M.I.T. He's been active in alumni fund-raising in his home area, Washington, D.C., and in his first year as chairman of the Alumni Fund Board, he presided over a fund-raising success in which the record was not just broken but demolished: From a 1986 Alumni Fund of $11.2 million to a 1987 Fund of $13.7 million, a 22 percent jump. Weinstein is also on the Corporation Development Committee.

How came Weinstein by his commitment to M.I.T.?

When he was an undergraduate, majoring in mathematics, Weinstein's initial goal was a teaching career, he says. He even went on to a master's degree with teaching in mind. At that juncture, though, a long-time interest in the law propelled him into law school, where he focused on corporate litigation. It was apparently the right career move, for today Weinstein is a partner in the respected Washington law firm of Covington and Burling.

His M.I.T. background has proven of great value in his practice, says Weinstein, a polished and self-contained man. "As things have turned out, I've tended towards the sorts of litigation where having an exposure to mathematics and science is helpful," he says. In large part, he explains, that's because of what M.I.T. taught him about how to approach complex subject matter.

An example is a current case on which Weinstein is working, "where I'm having to learn something about materials sciences—specifically, the mechanics of certain polymers. Materials science as such didn't really exist while I was at M.I.T. Nevertheless, I find that my exposure to what I view as a way of thought is helpful—even when I'm dealing with an area that's quite removed from my specific training."

Weinstein sees the Institute and its graduates as having the potential to make major contributions to societal progress in the years ahead. This potential is based on more than the knowledge and skills that M.I.T. imparts. "I think it's a university that gives people a certain type of intellectual integrity—a capacity for rational assessment of facts."

For the Alumni Fund Board chair, therefore, working for M.I.T. means serving a cause larger than simply strengthening a particular institution of higher learning.

Moreover, Weinstein says, his involvement with the Alumni Fund has

PHOTO: STU ROSNER

The creation, development, and management of technology are the most fundamental issues of our time.

turned out to offer a specific and stimulating form of challenge. M.I.T. alumni, he observes, have a noteworthy giving record: roughly half who attended as undergraduates, for example, contribute each year. But to meet its targets, the Alumni Fund must improve on this record, convincing still more alumni to make even larger contributions each year, and this, for Weinstein, is the heart of the challenge.

"How do you explain your case in the world where everyone's means are limited but where demands are immense?" he asks. "If you have an effective case, as I think we do, how do you convey it as vigorously as possible in the relatively short time available in each Alumni Fund year?"

Whatever the methods chosen, there's a ready gauge of their effectiveness. "Each year, inexorably, you've got a measure of results," says Weinstein. "You know whether you did what you thought you could, or worse, or better."

He pauses, then says, smiling, "Of course, if you did better, then you begin to think that maybe your forecasts were defective." Weinstein pauses again. "It's a lot of fun," he concludes. □

Carl M. Mueller, '41: Learning About Listening

For Carl M. Mueller, '41, the answer to the question, "Why work for the *Campaign for the future?*" is straightforward.

The creation, development, and proper management of technology are for him "the most fundamental issues of our time. I think our standing and well-being as a country, and really our western civilization, are highly dependent on them."

Given M.I.T.'s status as a leading, if not *the* leading, university source of new technologies and technological expertise, he says, the case for doing one's part for the forthcoming campaign is cut-and-dried. On the other hand, Mueller concedes that his may not be the most objective judgment on this point. "As corny as it may sound," he says, "I love this place."

Mueller, an imposing figure with a deep, gravelly speaking voice, says that this love affairs began more or less with the day, 50 years ago, when he entered M.I.T.

The Institute turned out to be fully as demanding as he expected it to be, says Mueller, who majored in mechanical engineering. Still, the young Pennsylvanian found time for non-academic pursuits—among them, participation in crew. (He and his crewmates, recalls Mueller, compiled a record that was highly satisfying except in one particular: "We lost to Harvard all four years.")

After Mueller's graduation and wartime service, fortuitous circumstances landed him in banking rather than in a field where his mechanical engineering background would be directly applicable. He did well, though, rising to become vice-chairman of the Bankers Trust Company, the New York-based international bank. And he's convinced his M.I.T. experience had a lot to do with his advancement.

It was partly the "how-to-think" skills he acquired here, which he says would have been applicable no matter what his career choice. But it was partly motivational as well. "The work ethic that one acquires around this place is critical," says Mueller.

As he pursued his banking career, Mueller also became involved with M.I.T. affairs. His involvement began with the Educational Council, whose members interview prospective students. It blossomed from there into an extraordinarily broad array of activities. Mueller is a longtime member of the Corporation—and in that capacity has been involved with three presidential search efforts. He has been a member of the Executive Committee for 17 years and the Investment Committee for 18 years. Mueller chaired the New York regional committee for a previous capital campaign and as Class Agent for 25 years helped lead his class's 40th reunion gift committee. Currently, he chairs the Corporation Campaign Committee, which has primary volunteer responsibility for gifts of roughly $500,000 and up.

Mueller says that though much of this work has been fun, "it isn't all beer and skittles." He goes on to explain: "Before I was involved with M.I.T., my experience was with the hierarchical system in business," he says. "That's where you take Churchill's approach—you know, 'I don't mind a certain amount of discussion as long as you don't take too long to agree with me.' So it was a while before I got used to the laborious decision-making process around here. If you're picking a president for this place, for example, you've got a mind-boggling amount of listening to do. But that's what collegial decision making is all about. I do understand the need for it, and at M.I.T. it works."

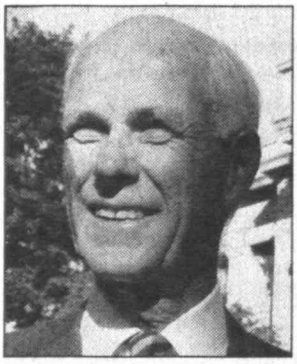
As for the satisfactions afforded by his M.I.T. activities, Mueller says most flow from his associations with people. Over the years, he notes, his alumni work has brought him into contact with some remarkable individuals. "Where else would I meet up with the likes of Jerry Wiesner, Paul Gray, Vannevar Bush, Howard Johnson, Julius Stratton?" he asks. "And that's not to mention some of the teachers I had, like Ascher Shap-

PHOTO: BRADFORD F. HERZOG

The Institute produces a significant proportion of the university engineering faculty.

iro, who was my thesis adviser and a really superb teacher.

"In many ways, the rather extraordinary array of people I've met is what epitomizes this place for me," he adds. "And on the other side of the coin, the number of pickles I've met here I could count on the fingers of one hand." □



D. Reid Weedon, '41: Undaunted by the Challenge of Raising Endowment

D. Reid Weedon, Jr. '41, has been a leader in the two previous M.I.T. capital campaigns. But he says the *Campaign for the future* poses a challenge unlike its predecessors.

What sets the current campaign apart, says Weedon, is its emphasis on endowment: more than half of the total goal is to go to endowment.

To Weedon, that's an extremely difficult goal. "I've been associated with campaigns for a number of other organizations as well as M.I.T.," he says, "and I've learned that the hardest type of money to raise is endowment. You can't realistically expect much endowment support from foundations or corporations," he explains. "So that means the preponderance of support has to come from individuals."

As a result, says Weedon, despite the record of generosity established by M.I.T. alumni and friends through the years, this fund-raising effort is clearly one that's going to put the Institute's volunteers to the test.

But if that sounds like an argument to discourage campaign volunteers, it's an argument that's apparently lost on Weedon. He has agreed to chair the National Campaign Committee, which will be responsible for campaign gifts between roughly $50,000 and $500,000. This means, among other things, that he'll oversee a network of more than 30 regional campaign committees.

For Weedon, who agreed in accepting the post to cut back to a half-time schedule as a senior vice-president at Arthur D. Little, Inc., taking on the committee chairmanship is only the most recent turn in a remarkably long and active association with M.I.T.

A key factor in his decision to enroll at the Institute in 1937, says Weedon, was his desire for a career in textiles. Specifically, he wanted training in both textiles and—because of the promise of the then-new synthetic fabrics—in chemical engineering.

When he was preparing to choose a major, though, Weedon learned that majoring in chemical engineering would prevent him from taking all the textile subjects he wanted that were in mechanical engineering. So he decided he could best meet his educational goals by majoring in general engineering instead. "Nothing like it exists now," says Weedon, "but at that time it was a haven for people who had interests that didn't fit neatly into one particular department's territory."

Weedon ended by not going into textiles after all, because his wartime service with the Navy's Aeronautical Materials Laboratory in Philadelphia introduced him to a new area of interest: "I got involved in packaging aircraft parts," he recalls, "and after the war a couple of other fellows and I decided to start a packaging consulting firm."

"I approached Arthur D. Little, Inc., to try to sell them our services," says Weedon, "and they said, 'Well, instead of our occasionally giving you some business, why don't you come to work for us?' " Weedon's acceptance of the offer helped guarantee continued close connections with M.I.T. The company's founder and namesake was an Institute graduate, and the firm was located next door to M.I.T. at the time.

Weedon, a tall, soft-spoken man whose features might well appeal to a sculptor who works in stone, joined the M.I.T. Corporation when he was president of the Alumni Association, and he has been a member for some 25 years.

Weedon has also filled a wide range of other volunteer positions; among the more rewarding, he says, are those related to student life. It was Weedon, for example, as chairman of the Visiting Committee on Libraries, who promoted the notion of an all-night library schedule. "In talking to students," he says, "I'd come to realize that having the opportunity to study around the clock was becoming more important, particularly as more students had to hold down jobs. So I pressured the Institute to keep a library open on a 24-hour basis."

Weedon says the new campaign will impose some duties unlike those he undertook in previous campaigns. One notable difference is that he expects intensive travel for meetings with his fellow volunteers. Being on the spot helps him make his case. "If I'm in California, for example," says Weedon, "alumni in business invariably say to me, 'Reid, you've got to realize that most of my people are graduates of California universities.' It's great to be able to say in response, 'Well that's fine, but are you aware that M.I.T. is producing a significant proportion of the university-level engineering teachers in your state?' " The figure he likes to cite is that roughly 10 percent of engineering faculty members nationwide are M.I.T. graduates. □

PHOTO: ED MALITSKY

UNDER THE DOMES

Celebrating Man-Vehicle Pioneers

Charles R. Burr, '70, is in ultrasound imaging for Hewlett-Packard Co., Waltham, Mass. Jehuda Ish-Shalom, Ph.D. '83, works on robotic sensing and control technology for IBM. Barry J. Linder, '78, is a resident in ophthalmology at the Washington University Medical Center, St. Louis. And John R. Tole, Sc.D.'76, is in communications engineering for Digital Analysis Corp.

Despite this remarkable diversity of talents, these people have two things in common: as its former students, they demonstrate the remarkable interdisciplinary reach of the M.I.T. Man-Vehicle Laboratory; and they all contributed to the Quaker-meeting atmosphere of the laboratory's 25th anniversary celebrated late last spring.

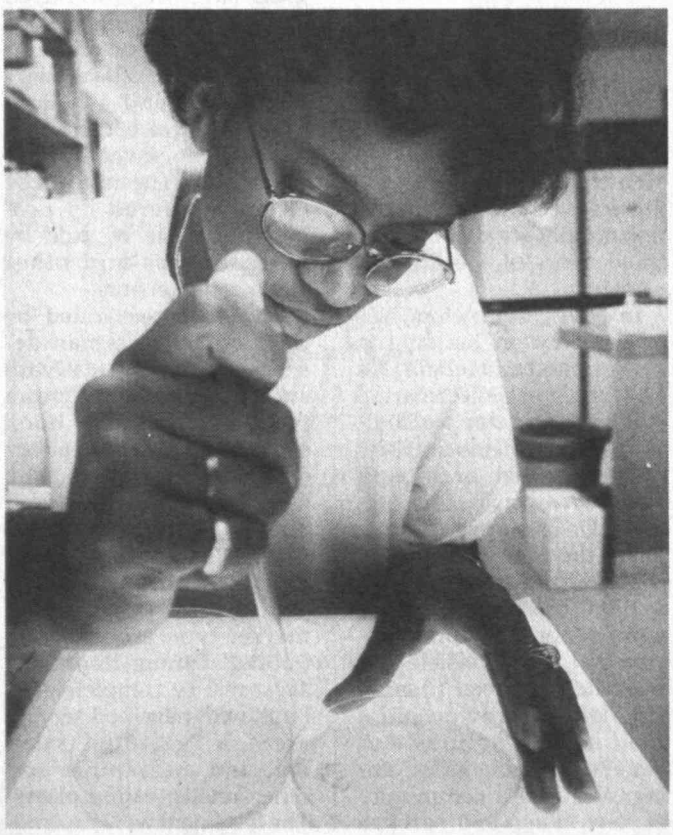
The concept that engineering had something to contribute to biology besides instruments was a new idea in the early 1960s when Professor Charles S. Draper, '26, asked his colleague Professor Yao T. Li, Sc.D.'39, to organize a bioengineering laboratory for the Department of Aeronautics and Astronautics. Professor Laurence R. Young, Sc.D.'62, who had just joined the faculty, came aboard, too. At the time Li was head of the department's Division of Instrumentation, Guidance, and Control; Young had just finished his doctorate with a thesis on the then-novel notion that there are corollaries between human eye movement controls and the fire control system being developed in Draper's Instrumentation Laboratory.

One of the first projects on which Li and Young started work was an automatic stabilization system for a motor bike. Another was the role of motion cues from a pilot's vestibular apparatus on his performance—a matter that, as it turned out, was "to keep us busy for 20 years," said Young in reviewing the Man-Vehicle Laboratory's history. There were physiological studies of the vestibular system and how to model it, new designs for control system displays, eye movement analyses, and research on the interaction between human and automatic control systems in the cockpit—all part of a research thrust that Young summarizes as "human control strategies at the sensory-motor level."

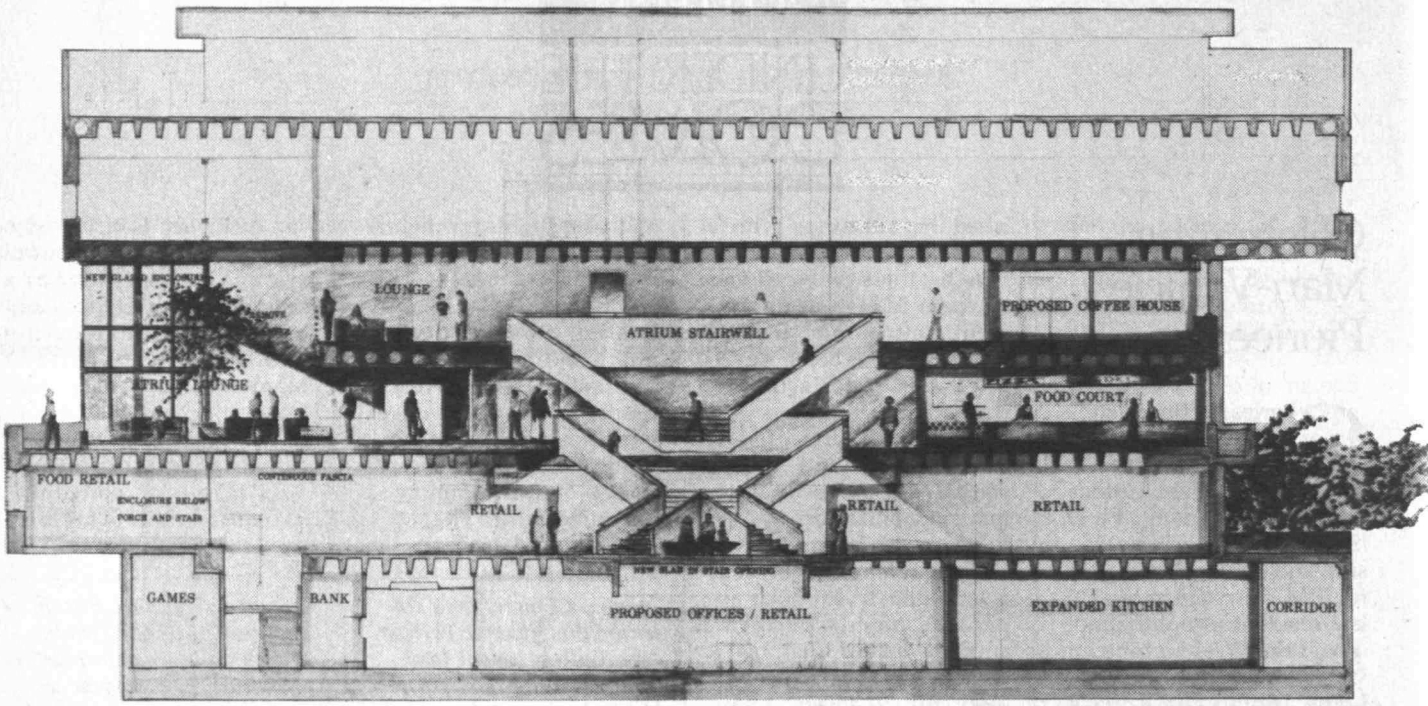
Then came the space shuttle era, and the Man-Vehicle Laboratory found itself uniquely equipped to work on the persistent problem of space sickness—sensory adaptation to weightlessness. Space flight was suddenly the laboratory's almost-singular preoccupation. Byron K. Lichtenberg, Sc.D.'79, became a payload specialist and took the Man-Vehicle Laboratory's experiment in adaption to weightlessness aboard Spacelab-1 in 1983. Meanwhile, many astronauts were coming to Cambridge to be tested before and after flights for their reactions to disorientation in an infamous rotating chair and a sled.

All of this activity and much more was recalled during the 25th anniversary reunion by those who experienced it firsthand—a small family deeply appreciative of the common experiences they shared as students and teachers. Susan A. Riedel, S.M.'77, who continues work on control systems and spasticity as a member of the Department of Electrical Engineering and Computer Science at Marquette University, Milwaukee, characterizes her M.I.T. experience as unpredictable, serendipitous. And also very congenial: "You're all a part of my life," she told the celebrants. □

Zenephia Evans, who's a senior this year at Talledega College, spent last summer doing research in M.I.T. biology laboratories. She was a participant in a Minority Summer Science Research Program sponsored by the School of Science and Graduate School. The idea, says the Graduate School's associate dean John Turner, is to give under-represented minority college students a glimpse of research "with the hope that they might decide to go on for doctorates."



More than 400 tons of concrete have been removed from the Stratton Student Center in a major remodelling to improve access and increase services.



$7.5 Million Student Center Overhaul

The collegiate commercial center that M.I.T. has never had—the Institute's answer to Harvard Square—is now the goal of major renovation of the first three floors of the Student Center.

In effect, the bottom half of the Stratton Building is being gutted and rebuilt. It's a $7.5 million project started August 1 and due for completion in September 1988.

The project architects have several goals, says Stephen D. Immerman, director of the campus activities complex: make the Stratton Building more inviting, with more places for informal interaction, more visible entrances, and better internal circulation; provide more food service options and better environments for dining; and add a community of new stores and services attuned to student and faculty needs.

Plans to achieve these goals have been developed by Bruner/Cott and Associates, architects, of Cambridge, working closely with Immerman and a "client team" on which there was "significant involvement" of students. The cost will be entirely covered by projected rents to be paid by food services and other commercial tenants.

To fill space vacated by the Coop, Immerman describes a shopping mall with such services as an ice cream parlor, pharmacy, book store featuring stationery and "trade" books (the Coop, relocated in Kendall Square, will continue to stock M.I.T. textbooks), 24-hour copy center, delicatessen, even a small supermarket-type grocery. The Lobdell Dining Room, he says, will be completely rebuilt, with new food serving areas, a "gigantic" salad bar, and mezzanines and other smaller eating places. The basement will house additional stores, including the Coop's optical and barber shops, Post Office, and Tech Tailor.

To solve the circulation and entrance problems, the Stratton Building will be changed completely, with a small three-story atrium containing lounge space replacing today's massive entrance stairs. Interior circulation also will be changed—open stairways and more accessible elevators.

And there will be substantial changes behind the scenes—improved kitchens and mechanical systems, including new plumbing and waste disposal.

To make all this possible, the first three floors of the Student Center will be closed—except for the Sala de Puerto Rico, where light food will be served—for the entire 1987-88 academic year. There will be access to the upper floors for student activities, the 24-hour Student Center study lounge, and the Project Athena facilities. □

Research Fund from AT&T

A $900,000 four-year grant from the AT&T Foundation to M.I.T. is aimed directly at reducing the scarcity of a vital Institute resource—unrestricted research funds.

"The strength of any important research center depends mightily on having flexible funds that enable bright, creative people to pursue their dreams and aspirations," said Provost John M. Deutch, '61, in response to the AT&T grant. But he noted that less than 1 percent of M.I.T.'s $300 million annual research budget is unconstrained by sponsors' contract requirements.

Appropriations from the new AT&T research fund have already been made to M.I.T. faculty working on high-temperature superconducting materials, diode laser arrays, and the development of a very small x-ray

RENDERING: BRUNER/COTT

laser facility. "AT&T believes that we and other industries must continue to help our universities to encourage the advancement of science through active research," explained Solomon J. Buchsbaum, Ph.D.'57. Buchsbaum is executive vice-president, consumer systems, at AT&T Bell Laboratories. □

Faculty Pay Near the Top

M.I.T. ranked tenth, twelfth, and fourteenth among 1,700 institutions of higher learning in the United States in the average salaries paid to professors, associate professors, and assistant professors, respectively, in 1986-87. These statistics were compiled for the American Association of University Professors and published last summer in *Chronicle of Higher Education*.

The highest average salaries for full professors were reported by Rockefeller University, New York—$74,400 compared with M.I.T.'s $62,400. Associate professors averaged $43,900 at M.I.T., assistant professors $35,700.

All three of M.I.T.'s averages were in the 95th percentile for doctoral institutions, and M.I.T. was one of only four U.S. universities with such high figures for all three ranks. The other institutions in this group are the University of California at San Francisco, Stanford, and Caltech. □

Small Role for Defense

While he was still in the race for the Democratic presidential nomination, Senator Joseph R. Biden, Jr. (D-Del.), made a faux pas about M.I.T.

The *New York Times* attributed to Biden the statement that "75 to 80 percent of those brilliant students at M.I.T., they're working on defense projects."

Not so, says Kenneth A. Smith, '58, vice-president for research at M.I.T. Smith reports that only 17 percent of the sponsored research on the M.I.T. campus in 1986-87 was funded by the Department of Defense. Furthermore, he says, "we estimate that only about 8 percent of our graduate students (and very few of our undergraduate students) receive stipends from work sponsored by the Department of Defense."

The largest 1986-87 research sponsor at M.I.T. was the Department of Energy (21 percent). In declining order, others listed by Smith were the Department of Health and Human Services (18 percent), the Department of Defense, the National Science Foundation (14 percent), industry (14 percent), NASA and other federal agencies (8 percent), and foundations and other miscellaneous sources (8 percent).

"All of this work on the campus is unclassified basic research," Smith emphasized. □

BY STEVE NADIS

Is There Life After MAD?

The room is quiet, the mood strained, as dozens of people hunch over computer terminals, typing on keyboards, tensely awaiting replies. With a grimace, a young man views the following message on his screen:

"You have both lost all strategic counterforce capability. Your ICBMs have either been destroyed in their silos or used in attacks on the other side. Your societies have sustained severe collateral damage . . . tens of millions of people dead, tens of millions more injured, and widespread economic disruption . . . Finally, this nuclear war has probably produced global environmental effects that neither country will be able to escape.

"The game is over. Please press 's' to indicate to control that you have finished."

It is just a game, but it is a game that mirrors grim reality: a world of two superpowers, each zealously stockpiling nuclear weapons in the hope of securing a strategic advantage over the other. Ironically, every step up in this deadly competition leaves the players less secure than before. Sound familiar?

The game, called "After MAD," was created by two M.I.T. graduate students in political science, Tad Homer-Dixon and Kevin Oliveau, '82. The game traces the course of the arms race between the U.S. and the Soviet Union from its early stages into the future. It leads to a point when the advent of missile defense systems and new high-accuracy weapons such as MARVs (maneuverable reentry vehicles) will make the present balance of terror obsolete. The superpowers' present strategy of deterrence is often referred to as mutually assured destruction, or MAD. Hence the name, "After MAD."

Pairs of players assume the roles of opposing world leaders who are faced with varying strategic situations in which they can choose to attack or cooperate. Players cannot communicate directly with their opponents, who remain anonymous. Nor do they know how their opponents have moved until after they have made their own moves.

Depending on how the game proceeds—there are 100,000 possible routes—a player may manage to avoid confrontation, be devastated in a nuclear attack, engage in two-way immolation, or destroy an opponent only to contaminate his or her own environment.

In the process of playing, students learn something about technical aspects of the nuclear arms race as well as game theory—a branch of mathematics that offers a numerical way of looking at military, economic, and political problems.

Most importantly, said M.I.T. Political Science Professor Hayward Alker, "students can learn more about themselves and the moral dilemmas one faces in making complex political choices."

"The game compels students to consider whether a country can ever 'win' a nuclear war," Homer-Dixon added, "and makes them confront the issue of whether military gain is worth the cost."

The development of "After MAD" was sponsored, in part, by Project Athena—a campus-wide test of the value of networked computers in undergraduate education. The game is one of two Athena-funded software packages available at M.I.T. and on the market for purchase and use by other institutions. It can be played on terminals connected to an VAX 750 or comparable computer that runs on UNIX 4.2.

"After MAD" originated with a casual request from Alker that the two students design a game representation of strategic affairs. Homer-Dixon wrote the text, while Oliveau wrote the software program. "I thought it would be relatively simple," Homer-Dixon said, "something I could do in a summer. I didn't imagine that the game would incorporate 110 matrices and 110 accompanying texts. Instead of a summer, it took almost two years."

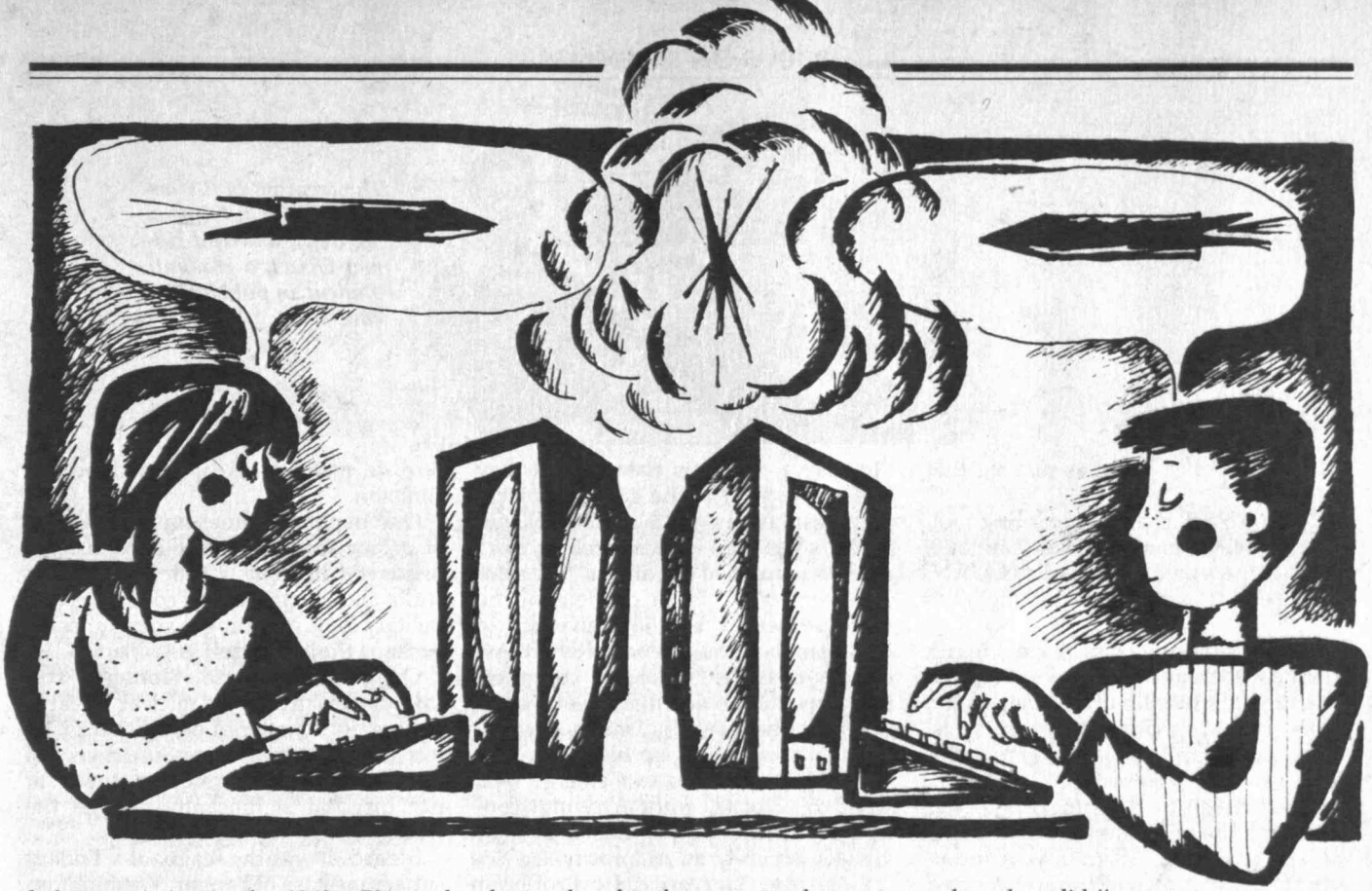
Oliveau, whose undergraduate degree is in computer science, also found the task more involved than he had expected. "Usually when you write a program, you write just one; but this required one program for each of 50 possible players, each moving at his or her own pace." The programs are linked to a central core through software devices known as sockets. "It practically takes a magic incantation to create sockets in UNIX," Oliveau chuckled.

"After MAD" revolves around five basic situations. The first three phases correspond to the U.S.-Soviet strategic

		Column	
		C	D
Row	C	(3, 3)	(−74, −63)
	D	(−63, −74)	(−74, −74)

The possible scores of a set of "After Mad" game moves is presented in a matrix. This example is from the early phase: a first strike with low accuracy weapons will destroy 25 percent of the opponent's military assets and a large proportion of the population centers. The scores represent the combined impact of attack/cooperate decisions on the military assets, economic and social well-being, and political power of each player, ranging from plus 99 to minus 99. If Row and Column cooperate (CC) they gain a modest three points; when one attacks while the other cooperates (CD or DC), the attacker loses 63 while the cooperator loses 74. As the game progresses, the weapons become more accurate, and the difference between the payoff for a first strike and the penalty for being attacked becomes more dramatic.

For information about "After MAD": Tad Homer-Dixon, Center for International Studies, MIT, Cambridge, MA 02139.



balance existing in the 1960s, 70s, and 80s, and phases four and five involve planned nuclear weapons technology and defensive systems.

In each move, a player has two possible choices, to cooperate (C) or to attack—"defect" (D), as it is called in game theory. Thus there are four possible outcomes: CC, CD, DC, DD, which can be represented by a 2 × 2 matrix. (*See accompanying matrix.*)

After each set of moves, the computer gives the players their updated scores and the next scenario—the new level of weapons technology at their disposal and the state of their economic and political affairs. Each then makes another move.

If both players cooperate for the entire game, they will proceed through the five phases and reach the "Congratulations" matrix. If one or both players attack, a nuclear war will ensue, in which case the game will either quickly end or follow a different track.

What has happened in games played by M.I.T. students? About half the players attack in the first three phases, before there is any real incentive to do so, said Homer-Dixon, who has recorded almost 200 "After MAD" encounters. Players manage to avoid nuclear war only about 15 percent of the time.

He observed that "women seem less willing to attack than men. People who describe themselves as conservatives (in a series of questions that precede the game) tend to defect early. ROTC students who play the game tend to go to war right away, usually by the second phase."

At every turn, the program requests that the players explain the reasons for their moves. By examining these comments, Homer-Dixon and Oliveau found that players take essentially objective numbers from the matrix and reinterpret them according to their own values. Some people try to maximize their own score; others try to maximize the differential between the two scores. Still others try to maximize the combined score of the two players.

"There are different interpretations of winning, and we leave that open," Homer-Dixon said. "Some people are adamant about not going to war. Others think they've won if their opponent has been wiped out, even if the environment has been destroyed in the process."

"I won. We both won," claimed one student. "Our jobs were to keep our countries healthy, and we did that."

"I lost. He lost, too," wrote another student. When the computer asked for the reason, he typed: "Now we are both radioactive waste."

Alker has noticed a tendency among students to "overgeneralize" what happens. "When they go to war soon, they conclude that everyone who plays the game goes to war quickly. However, when Tad pulls out the big (six-foot) graph showing that Dick went here and Jane there, it makes their fellow students think about why they ended up at war when they did."

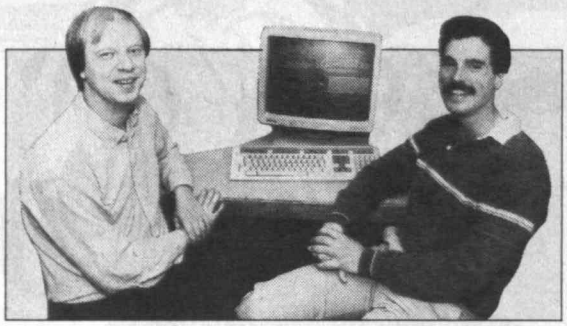
One student explained his motives for cooperating: "We are building trust. Every time I cooperate, I get stronger."

Another had a more calculating strategy that quickly led to war. Describing how he had duped his opponent by the spirit of detente, he said: "If you lull your opponent into a false sense of security, he will continue to believe in your goodwill. Then you can pounce in the future."

After being virtually destroyed in phase five, one student was asked why he thought his opponent had struck. "He went for the gusto," the student said. When asked what he would do next, he replied, "Fight back with what little I have and then die, because there is not much else I can do."

Although "After MAD" attempts to illustrate the perils of an increasingly lethal nuclear arsenal, Homer-Dixon discounts the predictive value of the game. For one thing, it assumes that the introduction of highly accurate "counterforce" weapons inexorably leads to a less stable world. "This is not a scientific representation of the world," he said. "It's an ideological argument. I'm taking the conservative viewpoint and showing where that leads you. Conservatives argue that the Soviets will soon have a tremendous incentive to strike first, and that it will cost us a lot to wait until they do so. (This is the standard 'window of vulnerability' idea.) They're setting up a prisoner's dilemma (*see accompanying ar-*

ILLUSTRATION: SOPHIE SCHILLER



The creators of "After MAD," Kevin Oliveau, '82 (left), and Tad Homer-Dixon, a graduate student in political science

ticle), and all I'm doing is making that explicit."

"After MAD" is a good learning tool, but it is just a game," Alker cautions. "Just as the world is not a PAC-MAN. People don't run around eating each other."

Oliveau's program can be used to run all kinds of games. "You're not limited to military situations," Homer-Dixon said. "You can represent various social situations—corporate scenarios, pollution scenarios, whatever."

Alker has used the program to run prisoner's dilemma games in his political science classes. "Before we computerized it, someone had to run back and forth with paper and pencil, communicating and recording each player's moves," Oliveau said. "With 30 players, that was a real headache.

The games are followed by a discussion, so that students can compare their play to that of others. "It can challenge their self-understanding," Alker said. "They may think they're following the path of altruism or survival, but they can observe that others using the same strategy may support very different values."

Alker has also had students play prisoner's dilemma games against a computer, which responded with the same move they had made, except for a random 10 percent variation thrown in. They were, in essence, playing against themselves, although few realized it. "In essays, students claimed that they had lost control of the game and were only responding to the other player, when in fact they were controlling more than 90 percent of the moves," he said.

"After MAD" is an offshoot of the work pioneered by the University of Michigan political scientist Robert Axelrod. Axelrod's simulated computer tournaments showed that the outcomes of repeated prisoner's dilemma encounters do, in fact, back up his theory that "mutual cooperation can emerge in a world of egoists, without central control, by starting with a cluster of individuals who rely on reciprocity."

However, Harvard Law Professor Roger Fisher, director of the Harvard Negotiation Project and co-author of *Getting to Yes*, is wary about applying the results of prisoner's dilemma games to the nuclear arms race. "It's an insightful analogy," Fisher said, "but the only thing that makes a prisoner's dilemma a dilemma is the fact that they cannot communicate or trust each other. If they can communicate and trust, there is no dilemma. To the extent that it is a prisoner's dilemma world, the question is not how do we play that game, but how do we change that game?"

Homer-Dixon acknowledged that the lack of communication is a problem often raised about "After MAD." On the other hand, he pointed out, "ordinary communication is not necessarily sincere. In many cases, it may cloud the situation."

One might also question the validity of posing strategic affairs in terms of a prisoner's dilemma, which makes a first strike highly tempting. If cool, objective military logic encourages sneak attacks, perhaps the logic itself is to blame.

On the other hand, Homer-Dixon said, the existence of a nuclear threat is not merely a matter of perception. "The fact is, technology drives us in certain ways. The high-accuracy weapons at our disposal significantly change the world."

Indeed, it was the reality of a Trident submarine base in Bangor, Washington, 70 miles south of Homer-Dixon's home in Victoria, British Columbia, that initially aroused his concern. "There was an important strategic target just south of us, and Canada had no voice in the policy that led to its construction," Homer-Dixon said. "If the U.S. is targeted, one of the first things that the Soviets will go after is this submarine base, which would mean curtains for many people in British Columbia as well.

"I became concerned; the world seemed to be going crazy, and I couldn't do anything about it. So I'm getting an education that I hope will help me change things for the better." □

For information about "After MAD": Tad Homer-Dixon, Center for International Studies, MIT, Cambridge, MA 02139.

Prisoner's Dilemma

The last two central matrices in the fourth and fifth phases of "After MAD" are based on a classic model in game theory, the "prisoner's dilemma." It poses a situation in which there is a potentially tremendous penalty for not striking first, a great gain if one can strike first, and a more modest gain from mutual cooperation. By building the prisoner's dilemma into their game, Homer-Dixon and Oliveau reflected their belief that the advances in weapons technology envisioned by the U.S. and the Soviet Union will make the strategic balance between them increasingly unstable.

The dilemma can be described by the following scenario: two prisoners are detained for a crime that they committed together. They are kept in separate cells so they cannot communicate. They are told that if both maintain their innocence, they will receive two-year sentences. If one admits the crime, while the other pleads innocent, the first will get off scot-free, while his accomplice will get five years in jail. Thus far, "logical" self-interest would seem to push each to confess. However, if they both confess, each will receive a four-year sentence, twice what they would have received had they both kept quiet.

Similarly, in the last two phases of "After MAD," the "logical choice" is to attack, because the penalty for trying to cooperate with an opponent who choses to attack has become very stiff. However, if both players attack, they are far worse off than if they had been "illogical" and cooperated. □

PHOTO: DONNA COVENEY

CLASS NOTES

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In these days when I regretfully record the passing of classmates, it is indeed good to take note of a happy event in these notes.

On August 7, the occasion was the 90th birthday of Elizabeth Howe, whose husband Julian passed away about three years ago. Over 100 of her life-long friends gathered at the Wellesley College Club to do her honor. It was a most happy event—a reunion of old friends, many of whom are M.I.T. affiliated.

I received greetings recently from **Herb Larner.** I am indeed appreciative of the frequent correspondence I receive from him—often on subjects of great interest but with little relation to M.I.T.

Faithful **Ted Braatan** sent us a most welcome note hand delivered. Congratulations on his Eunice's 90th birthday, Ted's 93rd birthday, and their 67th wedding anniversary.

I record with sadness the death last March 29 of **Georgius Cannon** of Pomona, Calif., with whom I enjoyed a lovely correspondence for over 50 years—the fruits of which often appeared in these columns. Georgius was a prominent architect and grandson of Mormon colonizer Brigham Young. After graduating M.I.T., Georgius practiced architecture in Salt Lake City for six years, then moved to California in 1925 where he practiced until 1953, when he returned to Salt Lake City. He was a fellow of the American Institute of Architects. Many of his commissions were homes, from Beverly Hills, Calif., to Federal Heights in Salt Lake City. He also designed Little America hostelries.

Two widows died recently. On March 12, Isabelle Poteat passed away. Jack and Isabelle joined us on several get-togethers coming up from Columbus, S.C. Only last August 15 Stella Grossman left us. We can recall her participation in many meetings and reunions in the Boston area. I also note that **Lawrence Allen** died on June 12, 1987—no details about his career.—**Max Seltzer,** Secretary, 865 Central Ave., Needham, Mass. 02192; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

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The October issue of *Technology Review* reported the death of **John L. Riegel** on May 1, 1987. He was very active in M.I.T. affairs, and the Alumni Office furnished some information on his activities which we think will interest his classmates. He was director of the M.I.T. Club of New York, a member of the Corporation Development Committee Area Council, solicitor for the M.I.T. Leadership Campaign, director of the Alumni Center of New York, a life member of the Alumni Council, a Bronze Beaver recipient and an honorary member of the Corporation Development Committee. We are proud of such a devoted classmate.

We also report the death of **Edward C. Anderson** on July 25, 1985. Mr. Anderson lived in Richmond, Va., and was the chairman of the board of Anderson Strudwick, Inc., of that city.

Received a postcard from Barbara and **Don Way** while on their vacation in beautiful New England.

We send our best wishes for your enjoyment of the fall—**W.O. Langille,** Secretary, P.O. Box 144, Gladstone, NJ 07934

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Johnny Rockefeller died last April. He was a consulting engineer in New York City and was widely known as having developed the stabilizer for the Norden bomb sight. Soon after graduation, he flew his own plane, operating from Red Bank Airport. He was a member of the Downtown Athletic Club and on the board of governors of Rock Spring Country Club of West Orange. He authored a book, *The Poor Rockefellers*. His home was Asbury Park. He is survived by a son, a daughter, and five grandchildren.

I am indebted to **John P. Lynch**'s son, John Jr., '52, for the following information on his father. John, Sr., lives at 139 Gregory Place, West Palm Beach, Fla. He'd enjoy hearing from any alumni in this vicinity. He remains in good health and has been visiting his daughter in Sandwich on the Cape. He walks a-half mile every day. His daughter is an assistant professor at M.I.T. John has two grandchildren and two great-grandchildren.

Hank Caldwell died May 7. He had long resided in Sarasota, Fla., and was a yachtsman. . . . **Forest Sanders** of El Paso, Tex., died on May 30.

Ken Roman writes that he continues to follow up his hobby of many years, which is painting. Ken lives at 10 Emerson Place in Boston.—**Harold Bugbee,** Secretary, Apt. 313, Country Club Heights, Woburn, MA 01801

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R. F. Miller

We learned belatedly in July that our class vice-president **Robert F. Miller** of Silver Spring, Md., died on June 4, 1987. Bob was a wonderful chap, the father of a big family, class photographer, and loyal son of M.I.T. He worked for many years in the U.S. Post Office Department in Washington, D.C., where he was assistant chief of Industrial Engineering from 1954 to 1969. He spent 29 years in private industry prior to entering government service. Bob served on the team which developed the original zip code concept, was instrumental in developing the nationwide regional center system for the post office, and assisted in the organization of the Post Office Service Institute of Bethesda, Md. He was active in Toastmasters International, and organized and was president of two Toastmaster clubs in the Post Office Department. He was also president of the Arlington Knights of Columbus Toastmasters Club.

Bob leaves a son, Robert F. Miller, Jr., of Ridgefield, Conn.; five daughters; and 14 grandchildren. We learned of Bob's death in a phone call from **Henry Taintor** who also informed us that **Whitney Wetherell** had given up his home in Harwich, Mass., and is living in a nursing home in Chatham, Mass.

Another bit of news that is slightly disturbing is that our class president, **Carole Clarke**, had a slight stroke this summer. He was not long in the hospital and sounded very chipper when I talked to him back home.

Elliott Roberts wrote me another good letter in July to tell that he, too, like your secretary, took a trip (many trips actually) to South America and liked Peru best of all.

Hilliard D. Cook died April 29, 1987, at a North Carolina nursing home. He served in the army in World War I, did research for the S.D. Warren Co. in Westbrook, Maine, then moved to Phoenix, N.Y., where he became general superintendent for the Sweet Brothers Paper Mill. In 1967 Hilliard moved to North Carolina and became an assistant professor in pulp and paper technology at North Carolina State University.

The sympathy of the class is extended to the families of Bob Miller and Hilliard Cook.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 11203; **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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Ted Miller, our reunion gift chairman, reported in July on the final results of the successful campaign he so ably headed. The total class gift presented to the Institute at the Tech Day luncheon on June 5th was $2,013,890. One hundred seventy-seven classmates participated, representing more than 91 percent of the class.

Charles Bray, soon to be 90, writes that he and his wife are now living in retirement in Heatherwood, Honey Brook, Pa. Originally in the class of 1916, Bray withdrew to serve in France in World War I. On his return he joined the class of 1922. He recalls the collapse of the tent at our graduation exercises in the Great Court.

Bill Elmer, in August, sent all classmates who attended our 65th reunion a copy of the NAAWP News, the publication of the National Association for the Advancement of White People. This organization and Bill strongly urge the nomination and election of David Duke as president in 1988.

I have a number of deaths to report. **Nathan Cherniack**, 89, of Kew Gardens, N.Y. died April 2, 1986. He is survived by his widow, Claire. . . . **Thomas E. Courtney**, 85, of Indianapolis, died February 11, 1987. He retired after 40 years as a chemist with Reilly Tar and Chemical Corp. He is survived by a sister and two brothers. . . . **Leland M. Rice**, of Montclair, N.J., died June 13, 1986. I have no information at present as to his career or survivors. . . . **Wilbur J. Woodruff**, 87, of Avon, Conn., died April 25, 1987. He is survived by a daughter, Ms. Mary Strittwalter.

John P. Livadary, 90, of Balboa Island, Calif. died April 7, 1987. At the time of his retirement in 1959 he was director of sound recording and processing at Columbia Pictures. His career in the movie industry began in 1928. He won three Oscars for his work on sound in *The Jolson Story*, *From Here to Eternity* and *One Night of Love*. He was an inventor with patents on magnetic tape and multitrack recording systems. Born in Turkey to French parents, John came to the United States after studying medicine at the University of Athens. He came to M.I.T. after U.S. Army Service in World War I. He first worked for Bell Laboratories before moving to the West Coast to enter the infant sound film industry. He was a founding member of the Academy of Motion Picture Arts and Sciences. John is survived by his wife, two children and six grandchildren.

Our sympathy is extended to the families of these classmates.—**Yardley Chittick**, Secretary, Rte. 1, Box 390 Ossipee, NH 03864

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You have received Class President **Don Moore**'s letter of July 10, advising that **Rock Hereford** will be our co-secretary. As he has temporary personal interests for a few months, I am continuing, anticipating Rock's production.

Ed Abdun-Nur, from Denver, Colo., has warned us that he will be visiting Boston in October, and we "darned well must see that he gets to the Boston Symphony."

A letter and clipping from **John Fitch** notes that **Boynton J. Fletcher** passed away July 8, 1987, in Vero Beach, Fla., following an extended illness. He earned an S.B. in civil engineering, hydroelectric option. He joined the Aluminum Co. of America as a structural engineer in Pittsburgh and spent his entire career there, retiring to Florida in 1976 as vice-president of engineering, construction, and purchasing. "Fletch" was a member of Tau Beta Pi and Theta Tau, honorary societies. He managed several sport teams at one time and in his senior year was manager of the Budget Committee and treasurer of the Institute Committee.

We have word from Mary Weissfeld, daughter of Professor **Avery A. Morton**, that he died March 25, 1987. A memorial service was held June 6 in Watertown, Mass. He received his Ph.D. in chemistry after studying at Harvard and the University of Chicago. In 1940, he was named director of the Research Laboratory of Organic Chemistry. He was a fellow of the American Academy of Arts and Sciences, a member of the American Chemical Society, New York Academy of Sciences, the American Institute of Chemistry, and the Watertown Book Club.

The son, John, of **John Twiss Blake** writes that his dad passed away June 26, 1987, in East Orleans, Mass. He earned a Ph.D. in chemical engineering after a B.S. from Tufts. He spent his career with Simplex Wire and Cable Co., Cambridge, moving from research chemist to director of research, retiring in 1966 as senior vice-president, secretary, treasurer, director, and member of the executive committee. His famous accomplishment was the invention of polyvinyl chloride, used in electrical insulation, films, sheets, and pipes. He was a member of three honorary societies and a number of other societies and clubs. He held patents on rubber-covered wires and submarine cables.

Alumni Records received a note from Martha Copeland, daughter, that **Donald B. Jennings** passed away June 13, 1987, in Ross, Calif. He received his S.B. in business and engineering administration. Our "Twenty-Five Year Report" reveals nothing of his career, except that at one time he was a lieutenant commodore in the U.S. Naval Reserve. We have been informed that he was the father of twins, Donald and Martha.

Dick Shea, our class vice-president, has decided that he prefers the sands of Florida to those of Cape Cod, so he has placed his hacienda on the market. As a parting shot, he, **Don Moore**, **Don Fife**, and Joe Martori joined together and reserved 20 rooms at the Hyatt Regency, Cambridge, for our 1989 reunion. For those who prefer dormitory living, McCormick will be available. Let's have your suggestions!—**Russ Ambach**, Co-secretary, 216 St. Paul St., Brookline, MA 02146

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Charles E. Peterson provides us with a new address: 4194 Ankar Park Dr., Bellingham, WA 98226.

It is with sadness that the passing of four classmates must be reported. **John Magee** died on June 22, 1987, at the Mercy Hospital in Springfield, Mass. Following graduation, John went into advertising. After some years, his father advised him to learn about stocks. Studying the market then became his life's work. In 1942 he joined with Robert D. Edwards to refine research into the method of stock investment known as the Dow Theory. In 1948, the two men published *Technical Analysis of Stock Trends*, which summarized their findings. Five editions of the book have been printed, and it has been translated into German and Japanese. John wrote two other books, *The General Semantics of Wall Street* and *Wall Street, Main Street and You*. John is survived by his wife Elinor, two sons, two daughters, and three grandchildren.

Maurice C. Conkay died on May 17, 1987, in Santa Barbara, Calif. He had been confined to a nursing home since October 1981 following a massive stroke. . . . **Franklin W. McLaren** died at the Millbrae Serra Convalescent Hospital in San Mateo, Calif., on December 13, 1986. He was a charter member of the American Society of Appraisers and a member of the Mechanics Institute of San Francisco and the Olympic Club swim team. He is survived by his wife Hallie, a son, a daughter, and three grandchildren. . . . **Hugh H. Brenan** died in Seminole, Fla., on April 10, 1987.—**F. Leroy "Doc" Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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We are pleased to note classmates who are still active. **Joe Levis**, who won six national fencing championships and was on three Olympic teams (winning the silver medal on one), is still participating in amateur and pro-amateur dance competitions all over this country and England. Although he has sold his tile business, he is almost as busy as ever as a consultant.

Got a card from Mombassa, Kenya, from Laura Ann and **Martin Grossman**, which reads, "Safari around Mt. Kenya plus two weeks to Mt. Kilimanjaro. We also gained a bit better understanding of conditions there."

James R. Killian Jr., former M.I.T. president and chairman, was one of four persons inducted into the Academy of Distinguished Bostonians by the Greater Boston Chamber of Commerce. As president of our class, Jim is still bringing honors. When I was at West Point a few years ago, I was in a room lined with big pictures of the Sylvanus Thayer awards, and there was one of Jim.

Charles Stark Draper died July 25, 1987. See the Obituaries section of this issue for a more detailed report of his activites and honors. Stark entered M.I.T. in 1922 after earning a B.S. from Stanford University, and we are certainly honored to have had him as a member of our class.

I hope that those of you who belong to SCORE, Service Corp of Retired Executives, are enjoying it as much as I have over the years. Those who don't should give some thought to passing on your knowledge to the young ones who want to go into business or to companies who need help. I'd like to hear from you.—**Donald S. Cunningham**, Secretary, 27 Lowell St., Braintree, MA 02184

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Bill Richards of Forestvale, Mass., writes to compliment the committee for our reunion program. The alumni office picked a capable driver, guide, and commentator for his bus ride through Boston, Salem and Marblehead. "Helen and I thought the luncheon at the Eastern Yacht Club was excellent. The visit to see the original painting of *The Spirit of '76* was worth the trip in itself." **Hal Edgerton**'s presentation at the class dinner was both interesting and humorous. He kept president Paul Gray strictly to task for his operation of the slide projector.

Bill has been the outstanding "farmer" of our class. In previous notes, we have mentioned his pioneering work in irrigation equipment and the production of hybrid strains of vegetables. In March of 1987, the New England Vegetable Growers Association presented him with a bronze plaque for "many years of service and contribution to the vegetable industry." True to the best of M.I.T. men, Bill has done a lot for his community. In June he received the Sandwich Education Award for "outstanding contribution to education in the Town of Sandwich." Bill has served 18 consecutive years on the School Committee—some years as chairman. He served as chairman for two school additions and is presently building two new K-8 elementary schools. Bill wins confidence at town meetings by presenting the cost of new construction without notes. In June he won more than respect by holding a $911,900 Massachusetts lottery ticket!

Elwood A. Church of Brattleboro, Vt. and his wife Elinor attended our reunion and confirmed his diversity of interests. Starting from M.I.T. with a Master's in electrical engineering, he is now a member of the National Audubon Society, The Wilderness Society, Appalachian Trail Conference, Seminole United Methodists, and the Union of Concerned Scientists.

Colonel **Donald P. Wylie** died on May 5, 1987, in Hanover, N.H. Don continued his education at Harvard Business School in 1930 and New York University Law School in 1936. He worked for York Ice Machinery and the New York Telephone Co. until World War II. ROTC started Don in Army Ordnance, where he served as an officer until 1946, including time spent in Asia. He returned to the Telephone Co. until recalled to duty in September 1951 as a Colonel in the office of ordnance research at Duke University. He retired in 1965 and moved to Hanover. Don enjoyed sailing, tennis and volunteered in the Service Corps of Retired Executives.

Harold Heins died suddenly on July 24, 1987, in Marblehead, Mass. He received his Master's from M.I.T. in physics in 1929 and was a microwave electronics engineer. Early in his career, Hal worked for Sylvania Electric in Salem on vacuum tubes for radios.

Throughout World War II he worked, as did so many civilians, around the clock on radar development in an all-out contribution to the war effort. A quiet man, not given to small talk, he was a highly respected tube engineer. He was co-inventor of the strobe-beacon airport lighting system for low visibility approach. After the war until 1958, he was director of engineering and a board member of Bomac Labs of Beverly, Mass., in the field of microwave devices.

As a special feature of their 60th reunion, Class of 1927 met at the Eastern Yacht Club in Marblehead, Mass., for cocktails and a buffet luncheon. Here pictured on the veranda are (front row, left to right): Ezra Stevens, Cecil Stevens, Harold Fisher, Mary Hawkins, Richard Hawkins; (second and third rows) Charles Dinan, Jerome Spurr, Alice Dinan, Jerry's sister Rosamond, Biderman DuPont, Gretchen Engel, Fred Willcutt, Robert Engel, Esther Heins, Betty Russell, Harold Heins, Thomas Russell, Joe Burley; (fourth row) Helen Richards, Kenneth Smith, Meg Smith, Charles Pope, John Drisko, Peg Badger, Sid Badger; (standing) Bill Richards, Russell Smith, Juliette Leach, Shirley Emerson, Edward Leach, Horace Emerson, Vera Lobo, Larry Grew, Paul Ivancich, Lillian Grew, Herb Johnson, Mildred Miller, Ervin Bramhall, Leroy Miller, Gus Lobo, Dall Sparre; (absent) Arthur Connolly, Elwood and Elinor Church, Larry and Eleanor Day, and Harold and Esther Edgerton.

In 1958 he became executive vice-president of Metcom, Inc., of Salem, Mass., designing klystrons, magnatrons, and other large microwave testing devices until his retirement in 1972.

Hal attended our 50th, 55th, and recent 60th reunions. An amateur musician, he played the flute at M.I.T. and throughout his adult life. He regularly attended the Boston Symphony Orchestra concerts. One of his hobbies was making large colored paper models of complex geometrical shapes. Another interest was astronomy, he owned several telescopes. We express our sympathy to his wife, Esther, and their two daughters, Marylyn and Judith.

Russell P. Westerhoff died July 12, 1987, in Ridgewood, N.J. after a long struggle against cancer. After receiving his Master's at M.I.T. in 1928, Russ started with the renowned consulting engineering firm of Ford, Bacon and Davis, Inc. in New York City. Before retiring in 1973, he was president and chairman of the board. First in evaluation and report departments, he advanced to assistant manager of the construction department, vice president and manager of engineering. This led to chief engineer and vice president of operations. He was also president of 4 wholly owned subsidiaries.

Russ was a member of many professional and charitable organizations, a member of the Advisory Council of the Ridgewood Community School for 12 years. He was devoted to M.I.T. in the M.I.T. Alumni Center in New York City and the M.I.T. Club of Northern N.J. His longest contribution was as our class estate secretary. He has attended all of our reunions and wanted to attend our 60th. A complete M.I.T. man in all aspects of his full life, we extend our class appreciation to his son Richard, and two daughters, Sally and Rev. Judith.—**Joseph C. Burley**, Secretary, RFD #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Av., Branford, CT 06405

28 60th Reunion

These notes will be in your hands near the end of the year, so we take this opportunity to wish all of you good health and happy holidays. Class of '28 has always been a class of spirit and enthusiasm—it still is! The response to our first 60-year reunion mailing has been truly astonishing. From our current listing of 270 classmates, we have received back 145 response cards for a total 54 percent return. Those planning to attend number 64, which is 24 percent of the class membership. Including spouses and guests, the attendance could well be 100 or more. These indications are far beyond any average or prediction for an M.I.T. reunion class of our age.

Newsnotes came with some of the cards. **Henry Lamb**, writing from Freedom, N.H., says that he has had a very busy year. He is still a member of his local school board. Last year he was installed as master of his local Masonic Lodge. Sadly, on December 3 of last year, his house burned down for a total loss. The greatest loss to him were his mementos and a collection of about 2,000 books. A gratifying aspect of the tragedy was the way his many many friends came to his assistance. To replace his home, he bought a "manufactured" ranch style house. There is still work to be done on the house, and this leaves him always with something to do. He is very happy with his home and environment.

We are sorry to learn from **Herman Jones** that his wife, Elsie, died April 15, 1986, after a very long illness. They had been married for nearly 58 years. Herman says that his own health is good, but he has moved into a John Knox total life care unit to be assured of care if needs be. . . . Olive and **Newton Foster**, who were in Cambridge last June for Technology Day, tell us that they moved to a retirement village and are busy clearing out their Rutherford, N.J., house, which they will sell. . . . **Elliot Grover** reports that they have moved (October 1986) to a retirement community in Clemson, S.C., where they own a townhouse. Their daughter lives nearby. Elliot says they still visit Lake Winnipesaukee each summer.

A note from wife Novice tells us that **Irl "Tex" Sandidge** is recovering from a stroke he suffered in October of last year. He is following a program of therapy and looks forward to a good recovery. . . . From **Ernie Knight**: "We have waited a long time for this big 60th to top off a series of wonderful reunions." . . . **Carl Lockhart** says he is unable to attend the 60th but will be there for the 75th! . . . **Nap LaCroix** went through a major sur-

PHOTO: BEEDE PHOTOGRAPHICS

gical operation for a large abdominal aneurism of the aorta last June, and wife Gertrude had a fall that caused a light pelvic fracture. Nevertheless, they are still planning to be on hand for the big event next June.

With deep regret we must now report the deaths of four classmates. **Richard Roth** died June 9, 1987, as the result of a heart attack. Dick graduated in Course IV, architecture, and spent his professional career with Emery Roth & Sons, an architectural firm established by his father, where Dick became partner, president, then board chairman. His firm is widely respected, and he personally enjoyed a good number of prestigious professional posts and honors. . . . **Dudley W. Smith** died May 13, 1987. Dud graduated in Course XV, business and engineering administration. In his earlier professional years, Dud was superintendent of operations for Oahu Railway and Land Co., Honolulu, Hawaii. In later years, he was with Pratt and Whitney Aircraft. We had a cheerful Christmas and year-end letter from Betty and Dud only a few months ago.

John F. Wegforth died April 1, 1986. The information was sent by his daughter. John received his S.M. degree in the Department of Aeronautical Engineering as a member of our class. His active years were with the U.S. Navy as rear admiral. . . . **Duncan P. Whittaker** died February 19, 1987, in Portland, Maine. Whit graduated in Course VI, electrical engineering, and during his professional life was first with Stone and Webster in Boston, then later was chief electrical engineer at the Panama Canal and Dravo Corp. (Pittsburgh). He traveled so extensively as to include all six continents of the earth. To the families of our deceased classmates we extend our heartfelt sympathy.—**Walter J. Smith,** Secretary, 37 Dix St., Winchester, MA 01890

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Lewis Hess and his wife Mary Helen of New Smyrna Beach, Fla., are enjoying their golden years. They have one child and four grandchildren. They list travel, music, and reading among their hobbies. . . . **Ira H. Abbott** of Wolfboro, N.H., who lost his wife Martha a few years ago, writes, "I can't continue my preferred hobbies of golf, hunting, and fly fishing because of bad legs. Thanks for the birthday card." Ira has three children and six grandchildren, who form the basis for his comfort and joy in life.

Bill Bowie and his wife Sally of Olmstedville, N.Y., paid us an impromptu visit at our Florida home in Boca Raton. A note from Bill reads, "Now that you got me involved once again as class agent, it is appropriate for me to express M.I.T.'s appreciation for your generous contribution to the Alumni Fund. We hope that you are having a fine summer as we are here—hot, but lots of worthwhile activities, such as music and ballet. We hope to see all of you this fall if a reunion committee meeting is arranged." Bill was our class agent for 20 years until our 50th reunion, at which time he was elected president of our class for a five-year term. **Dexter Osgood** was elected class agent. When the latter died suddenly, Bill graciously accepted to be class agent once again.

A note from **Harold M. Weddle** of San Diego, Calif., reads, "First, I would like to thank you for my birthday card. I did not respond purposely until after June 22, so that I could report that Esther and I just celebrated our 55th wedding anniversary, having spent 55 happy years together. I always look forward to our class notes in the '29 column." I like to remind some of our classmates that Harold was responsible for that wonderful humorous poem, "Life Begins at Eighty," which was published in the July 1975 issue of *Technology Review*. We all got a big laugh out of it. His hobbies include lawn bowling, walking two miles a day six days a week. The Weddles have two sons and six grandchildren.

Larry Horan of North Chatham, Mass., writes, "Yesterday I received a telephone call from Eleanor, wife of **John Ade Plugge** of Chevy Chase, Md., that he had just passed away. A strong friendship developed between us during the 50th reunion. He stayed with us at our home, as we are not very far from Chatham Bars Inn. I was really shocked to learn of his demise, as he was a most beloved friend from our undergraduate days.

"We had three house lots in Rye, N.H. Sold them and bought our present house on the Cape. Prices of these modest dwellings have increased their value astronomically which baffles my mind. I recall the mid-1930s depression days in New York City, with apple vendors and soup kitchens, where I lived on Long Island and roomed with **Arnold Conti.** I think **Paul Donahue** also lived in Bayside, Long Island. He and Conti formed a partnership and built some large buildings. For a while during the depression, I worked in a newspaper office, edited a four-page leaflet called *Research Reports*. The pay was poor, so I started bottling honey and wholesaling to jobbers. For some years, I had a power boat, dug clams, and trapped lobsters, (with limits). Isabel is allergic to lobsters and I don't care much for clams." During the period Larry is referring to, I had gone into the food and catering business, and I used to see Larry often in the Boston produce market selling honey and **Louis Demakis** of Lynn, Mass., who had gone into the manufacture of frankfurts—three M.I.T. engineers conforming with the times trying to make a living.

I regret to announce the deaths of these classmates: Rear Admiral **Robert S. Hatcher,** June 12, 1985; **Fleming R. Hurt,** May 3, 1987; **Daniel J. Collins,** March 19, 1987; **Emery M. Low,** May 3, 1987; and **John Ade Plugge,** July 6, 1987.

Lois E. Low, wife of Emery, wrote with additional information. "Emery retired on January 1, 1977 from American Totalisator Co., where he was chief mechanical engineer. Our son, Emery Morton Low II, was the third generation to graduate from M.I.T. His son now is an analytical engineer with the Santa Fe Railway Co. in Topeka, Kans."

Eleanor, wife of John Ade wrote: "He leaves me, two sons (James R. and John O.), and six grandchildren. He enjoyed the class news and, until recently, the scientific articles in *Technology Review*."—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

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From Albuquerque, N. Mex., **Bill Perret** reports that he retired in 1973 from the Sandria National Laboratories where he spent most of his time planning and analyzing measurements of ground motion near nuclear explosions. His post-retirement activities include archeological surveying in New Mexico and photographing and videotaping birds and "anything else that moves." In the spring of 1986 Bill attended an M.I.T. picnic on Casey Key, near Sarasota, where he met **Bob Crowell.** The Perrets have two sons, both of whom graduated from the University of New Mexico. Their younger son Robert received a Ph.D. from M.I.T. and is now director of Systems Analysis at the Lawrence Livermore Laboratory.

Bill Spahr lives in Smithtown, Long Island and is still bowling but has just about given up golf. He still keeps in touch with **Ted Green** and **Tom MacLaren**. . . . **Ann Fahnestock Cody** writes from Zephyrhills, Fla., that her father Frank has now sold his longtime home, Sycamore Lodge, in Roslyn Harbor, N.Y. Frank is now largely confined to a wheelchair at a nursing home near his daughter's home. The Codys have a van equipped with a ramp by means of which they are able to take Frank for excursions and a holiday dinner or two at home."

We have at hand a long-delayed report that **Willard (Bill) Paine** died in May of 1986. According to my records Bill spent most of his career working for the Bendix Corp. and its subsidiary, Bendix-Westinghouse Automatic Air Brake Co., first in South Bend, Ind., then in Owosso, Mich., Detroit, Mich., Kansas City, Mo., and the headquarters office in Elyria, Ohio. At the time of his retirement he was chairman of the board of B-W, as well as a trustee of the Elyria Hospital, director of the Lorain County Savings Bank, the Union Commerce Bank of Cleveland and an active member of S.A.E. After his retirement, he and his wife Marjorie moved to La Jolla, Calif. where they built a "beautiful 10-room house with a marvelous vista of the Pacific," equipped with a Lowery organ and located near the top of Mt. Soledad. Bill was a widower at the time of his death, he is survived by a son, a daughter, and six grandchildren.

One of the problems with which our surviving classmates have had to deal is the loss of a spouse after many years of marriage. Sad communications have come in from **Henrik M.C. (Hank) Luyx**, whose wife Barbara died about a year ago after 53 years of marriage, and from **Vince Thormin**, whose wife Maudie died last July after 52 years of marriage. Hank lives in Gaithersburg, Md., and apparently has health problems that keep him pretty close to home. Vince lives in Calgary, Canada, and plans to carry on in the ministry. Both Hank and Vince are fortunate in having children and grandchildren who live nearby.—**Gordon K. Lister** , Secretary, 294-B Heritage Village, Southbury, CT 06488

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Sadly we report the death of another classmate, **Dick C. Holihan,** who passed away on March 21, 1987. Our sincere sympathy to his family and friends.

A note from **George L. Hickey** reports his present address as 2027 Blue Mountain Rd., Saugerties, NY 12477. He writes, "I enjoyed our 55th last year in spite of all the rain. It was good to see some old friends after all these years. My daughter and I recently returned from an interesting trip to Nova Scotia and Newfoundland. There was still some snow packed in the ravines. Then we struck the heat on our return to New York."

Helen (my wife) and I recently returned from a pleasant trip to the Canadian Rockies where we saw Lake Louise, Banff, and Jasper. First we flew to Chicago, then changed planes to Calgary, Canada. I think I enjoyed the trip more because I didn't have to walk, which I don't like. After flying to Calgary, we covered the rest of the trip by bus. Both of us thoroughly enjoyed the trip.—**Edwin S. Worden,** Secretary, Box 1241, Mount Dora, FL 32757; **John Swanton,** Assistant Secretary, 27 George St., Newton, MA 02158

33 55th Reunion

Professor **Morris Cohen,** pre-eminent academic leader in the field of materials science and engineering, has been named recipient of the Kyoto Prize, which is awarded annually to distinguished individuals in advanced technology, basic sciences, creative arts, and moral sciences. The prize will be awarded November 10 in Kyoto, Japan. (See story in the October issue, p. MIT 51.)

George Ropes reports that he's enjoying life as a computer coordinator in a private school and as a math editor for the publisher of a computer software magazine. All this is going on in Goldens Bridge, N.Y. . . . **Leon Hyzen** is spending his days in San Clemente, Calif., cultivating flowers and vegetables and, so he reports, weeds.

We mourn the passing of three classmates. **Richard B. Smith** died July 19, 1986. Mrs. Eileen M. Smith may be contacted at 613 Ocean Dr., Key Biscayne, FL 33149. . . . **James E. Norcross** died June 5, 1987. Mrs. Helen Norcross may be reached at Granite Farms Estates, 1343 Baltimore Pike, Wawa, PA 19603. . . . **Robert Fuller** of 2138 Timlin Hill, Portsmouth, Ohio died March 2, 1987. We have no further information at this

time.—**William B. Klee**, Secretary, Box 7725, Hilton Head Island, SC 29938

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After a brief respite in the last few issues, information on losses in our ranks is coming in again. Going back the farthest, **Simon Malkin**, of Malden, Mass., suffered a heart attack on December 25, 1985. Simon had worked for over 30 years as a chemical engineer with the Badger Co. in Cambridge. He was an active volunteer at the Shriners Burns Institute and the Massachusetts General Hospital. For the last two years he was the "volunteer gardner" at the Malden Public Library. Losses this close to a holiday seem especially unfortunate because future celebrations must unavoidably remind of past sorrows. Simon is survived by his wife Jeanette, a daughter, a son, and four grandchildren.

Malcolm Fisher, of Jamaica Plain, Mass. died on May 11, 1987. No other information is available at this time.

Howard Reichart died unexpectedly in the Nyack Hospital in New York on May 10, 1987. His home was in Mystic, Conn. Howard was valedictorian of our class. He had been associated with Union Carbide for 43 years and at the time of his retirement in 1977 was vice president of the chemicals and plastics division. An avid yachtsman, Howard was a member of the Larchmont Yacht Club, the Off-Soundings and the Storm Trysail Clubs, the Mason's Island Yacht Club, and was a former member of the New York Yacht Club. He is survived by his wife Elizabeth, two sons, two daughters, and seven grandchildren.

Our most recent loss is that of **Willard Simonds**, who died in Gulfport, Fla., on July 7, 1987. He moved to Gulfport in 1947, and worked as an electrical engineer for the Florida Power Corp. until 1975. In 1969 he was named manager of Florida Power's fuel and special projects department with responsibility for coordinating purchase, transportation, and efficient use of fuel used in the company's generating plants. "Bill" was a consulting engineer for the city of Gulfport and was very active in the M.I.T. Club of Tampa Bay. At the time of his death he was a director of the club. Survivors include his wife Anita, a son, and two grandchildren.

On behalf of all our class, I express sympathy to the families of our past members.

In a more pleasant vein, I have a note from **Peter Kalustian**, in Boonton, N.J., that brings us up to date on his life. In part he writes, "My international consulting engineering practice and travel still continue. In addition to the United States, recent clients are located in Australia, Malaysia, Columbia, Jamaica, and Mexico. My health stays good and I enjoy the challenges and new friendships—all important in keeping fully occupied since my wife's demise in 1978.

"As for recreation, I am well on my way to qualifying as a downhill "ski bum." This past season I enjoyed some seventy days of skiing in the northern and western areas and am a member of the *70 Plus Ski Club*. This, among other things helps me continue keeping up with my early teen-age grandchildren.

"In summer I switch to water sports and walking. Fortunately, my daughter and her family live next door and my son is in lower Manhattan, so the family stays together."

I am writing on August 8. On August 10 your peripatetic secretary is leaving with some other railroad "nuts" to ride trains in Switzerland for two weeks. The trip will include a one-day charter of the "Nostalgia Orient Express" (the real thing!), the major scenic lines in the country, and ends up riding the French high speed "T.G.V." train from Lausanne to Paris. Talk about having "Great Expectations!"—**Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Satucket Rd.), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, MD 20815

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Back at our 50th reunion I talked with Sue-Jo and **Lester Moffatt** and told them I would be interested in news of their children. Early in July I received a packet of material with Sue-Jo's note saying she was enclosing "too much material" but included a "bare-bones" report from which I quote. Lester's son, Hugh, "is recognized as one of Nashville's finest song-writers. Within the last ten years he has composed lyrics and music of some thirty songs recorded and released by some thirty top-flight singers in country music." Now Hugh has signed as a singer with Milo Records. To help promote his first album *Loving You* he has become a wandering minstrel with summer engagements which took him from Winnipeg and North Carolina to New York State and New England, including Cambridge and Worcester. Lester's daughter Katy was nominated as one of five finalists in the Academy of Country Music's "Best New Female Vocalist" in 1985, and this year has sung in Switzerland, Austria, and Canada, as well as the U.S. I have a library of information to pass along to anyone wishing more information.

Mrs. **Avon Pitman** sent a short note about Avon stating that Avon has been incapacitated with Parkinson's disease since 1960 at age 48. He is a course IV man and lives at 227 N. Weatherly Dr., Beverly Hills, CA 90211.

Jack L. Staunton died May 10, 1987 after a long illness. He received his BS in Sanitary Engineering and was a member of the American Society of Civil Engineers and the American Academy of Environmental Engineers. He was a resident of Westport, Conn., for 37 years. Jack is survived by his wife Mimi, and daughter Vicki.

William Earl Peterson passed away on June 30th. He and his wife Adele have lived in Austin, Tex. for 14 years. He was in Course VI, was a Lt. Col. USAF (ret.) and was an employee of the FAA until he retired in 1973 as area manager. He leaves a daughter, Peggy Dennis of San Diego. A second daughter, Camilia, died in 1983. Adele writes that they really enjoyed the 50th and had been looking forward to the 55th.

Your secretary would like to hear from some of you who have *never* written since you graduated —give forth all, the cupboard is empty.—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

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Our president, **Alice Kimball**, reports that she, **Herb Borden**, and **Vince Estabrook** represented our class at the Technology Day luncheon this year. **Bill Metten** was among those listed for the Pops Concert.

Mal Graves, in a note to the Alumni Office from Lynchburg, Va., says, "Since the first of this year, I have been serving as administrative assistant for the Lynchburg Peace Education Center."

Belatedly, we have learned of the death of **David A. Blanton, Jr.** from cancer on December 12, 1985, in St. Louis. As reported in the *St. Louis Post-Dispatch*, Dave was president and chief executive officer of The Blanton Co., producer of oleomargarine, until 1962, when the company was sold and he retired. At that time he said, "I am fortunate in that I now have time to help the less fortunate—this is fortune enough for me." And, indeed, he so devoted his time and financial assistance, preferably anonymously, to his Catholic Church and related organizations and served on their boards of directors. He regularly spent several days a week visiting the needy. Dave's widow resides at 230 S. Brentwood Blvd., No. B11, St. Louis, MO 63105. Let us remember Dave, our admirable classmate.—**James F. "Pat" Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171; **Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745

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Robert C. Glancy, Jr. of White Plains, N.Y., retired July 1, 1980, from AT&T Long Lines as planning engineer. His hobbies and volunteer work include U.S. stamp collecting, AT&T PC6300 graphics spreadsheets, tax counseling through AARP, membership in Telephone Pioneers, and gardening (in and out). He rebuilt his cottage in Meredith, N.H., which had been destroyed in a tornado. Travels include Hawaii, Caribbean, Panama Canal, Great Britain, Holland, Belgium, France, Scandanavia, and Leningrad. Wife Carrie's main interests are sewing, cooking, and volunteer work. Children are Robert III, Carol (colonel U.S. Air Force), and Sharon. Grandchildren are Robert IV, Jennifer, Michael, and Amy. Robert writes, "having just returned from our fabulous 50th, not much new. We returned home via our New Hampshire cottage to inspect after winter break-in. Seeing everyone at Cambridge and especially at Wequasset was a highlight to be long remembered. Made a big splash wearing my red blazer in running a bridge at church. Next a family reunion in New Jersey. First grandson wedding in Pennsylvania. Then we visit our colonel at Wurtsmith AFB at annual inspection. Then on to Minneapolis to see our son's new home."

Gray Jensvold, Morrisville, Vt., writes, "Sorry to miss our 50th, but nature has given me Parkinson's Disease, which makes walking very difficult. Damn! Would enjoy seeing any classmates who might be passing near". . . . **John B. Pitkin** of Laguna Niguel, Calif., retired March 31, 1974, from Lockheed—research and development. He writes that travels have taken him down the West Coast to attend Lockheed retirees' meetings and visit his daughter in Washington state. Wife Marian's main interest is counted thread needlework. Activities are limited because of Parkinson's Disease.

Albert Shulman of Hartford, Conn., plans to retire soon. He currently is president of his own company, Realty Services in Hartford. Travels include England, France, Switzerland, Israel, China, Japan, Hawaii, Caribbean, Southeast Asia, and Hong Kong. Wife Rachel is a creative artist. Rachel's collages have been exhibited many times. Albert and Rachael have ten grandchildren, 6 months to 19 years.

V.N. Vaughan, Jr. of Chatham, N.J., retired in May 1980 from the AT&T Co., as director, Data Communications Standards. V.N. is currently self-employed as a consultant on computer communications. He is an IEEE fellow, received an honorary doctor of science degree from Randolph Macon College, and is listed in *Who's Who in Engineering*. His hobbies and volunteer work include activities in the Presbyterian church and various clubs, gardening, and sailboat racing. Travels have included trips to Europe, South America, Africa, Asia, Australia, Japan, and islands in between. Wife Sally's main interests are art, mostly painting but also sculpture, flower arranging, and photography. V.N. writes, "I especially enjoyed my work with the AT&T Headquarters Staff, 1950-1980. I had the privilege, pleasure, and fun of being the cornerstone in leading the Bell System from the era of telegraph and teletypewriter to modern data communications. After retirement in 1980, I was a consultant to several companies, as well as the Department of State, Inspector General, Office of Communications, and Office of Personnel. Still consulting on reduced scale."

Thomas L. Hallenbeck of Toledo, Ohio, wrote **Dick Young** to thank him for sending reunion notes. . . . **Robert Paul Rudy** also wrote Dick saying, "The great enjoyment that Joan and I had at the 50th is still continuing! We are now off for 12 days to Camden, Maine, then Campobello, and back to New York City and, hopefully, a reduced work schedule. At the end of August and early September, we're off to Scotland and Wales, then to London to see 'Phantom of the Opera' and 'Les Miserables'."

John Clinton Robbins, Jr. of Irvington, Va.,

wrote Dick saying, "I raised **Walt Blake** on the phone early Saturday morning during his last visit to an empty house. He and Susan were moving to Tryon, N.C. Their house in Hilton Head, S.C., had been sold and all their possessions had been loaded for shipment. They seemed disenamored of Hilton Head because of the high humidity and the 'tourista' atmosphere."

Professor **Martin Deutsch** was honored at an Institute-wide retirement dinner for 47 years with the Physics Department. . . . Dr. **L. Charles Hutchinson** of Marshfield, Mass., writes, "Have recently been attending Bridgewater State College and University of Massachusetts in Boston. Used Ph.D. from M.I.T. as part of board certification in psychology and must now serve an internship to receive license as a clinical psychologist in family therapy and child psychology. Am looking for a good place nearby to serve the internship."

Stanly D.Zemansky, Paradise, Calif., had his book, *Contracting Professional Services*, published in 1987 in cooperation with the National Institute of Government Purchasing. The book is intended as a guide to professional service providers, procurement personnel, and informed government officials to help them achieve more open, fair, and equitable awards.

I regret to report that Eleanor Speh of Huntington, N.Y., reports the death of her husband, **Herm Speh**, in August 1986. . . . **Harry D. Crapon, Jr.** of Ocean Springs, Miss., who retired from the Ingalls Ship Bldg. Co. of Pascagula, died in May 1986.

It is with regret that I report the following note from **Mel Prohl**, Boxford, Mass.: "I enclose a death notice for **William E. Burns**. Bill attended the reception and dinner preceding the Pops Concert at our 50th reunion with his wife and daughter Sharon but was not physically up to participating in the rest of the reunion program. Mabel Coleman, wife of the late **Wells Coleman** and Bill's sister, attended the 50th as a special guest of our class."

William E. Burns of Amherst, N.H., died June 22, 1987, in Burlington, Mass. Bill was employed as a research engineer with Polaroid Corp., was a research engineer with the M.I.T. Servomechanisms Lab, operated his own development and pilot production company, and then became chairman of the Department of Natural Science and Mathematics at Newton Junior College, Newtonville, Mass. He leaves his wife Helen (Loehr), seven sons, three daughters, and nine grandchildren.—**Lester M. Klashman**, Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

38 50th Reunion

By now you've made your plans to attend our 50th reunion, June 1-3 on campus and June 3-5 at Chatham Bars Inn on Cape Cod. Plans include a clambake on the beach at CBI.

The 50th class gift is progressing. As of last June, we had reached 63 percent of our goal. But not to relax; grab your checkbook if you haven't anted your share! There's good news, however, since whatever you give or pledge counts in M.I.T.'s campaign for the future.

A belated death to report: **Sidney Mack** passed away last May 18 at Pine Grove Mills, Pa., after a brief illness. Sid, you will remember, was an electrical engineering major and came from Portland, Maine. He retired in 1978 from Penn State University, where he was an associate professor in mathematics. Sid is survived by his wife Marjorie and a daughter and son.

Sandy and I wish you all Christmas greetings (the card money saved goes to the class gift!). And, we'll see you in June.—**A.L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Richard J. Donohoe received the M.I.T. Corporate Leadership Award to honor alumni who are chairmen, vice-chairmen, presidents, or managing partners of leading business, financial, or industrial organizations.

Hewitt Phillips and Viola attended the U.S. indoor championship model plane meet at Johnson City, Tenn., in the University Field House, where the ceiling is 122 feet above the arena. Hew is retired now but reports to aero classmates: "After working at NASA 45 years, mostly in flight research, I finally got to run a wind tunnel test."

Jim Barton and Mary hosted friends and neighbors on their deck overlooking Lake Washington last July 4, and **John Alexander** and Nancy led singing of the national anthem.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., Gig Harbor, WA 98335

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An award of a Paul Revere bowl, in honor of his distinguished corporate leadership, was presented last April to **John J. McMullen** by M.I.T. Chairman David S. Saxon and President Paul E. Gray.

A note from **Raymond E. Keyes** says, "I felt like a big league ball player when I had rotator-cuff surgery in my shoulder, done by the surgeon who does it for the Seattle Mariners. The operation was done three years ago, and the shoulder is now great. However, it is not the shoulder of my throwing arm."

Alfred N. Ackerson writes, "Retired from Chrysler in 1982. Have my own gear manufacturing consulting business. Currently under contract to Transmissiones y Equipos Mecanicos in Queretaro, Mexico. My wife Marijean and I are raising our second family of four children. The first four left the nest long ago. Our adopted children are ages 7, 13, 16, and 18. Never a dull moment!"

Joseph P. Paine writes, "I retired in June 1986 from the MRC Division of Chamberlain Manufacturing Corp., where I had spent the previous 17 years handling various programs and management functions. My wife Anne followed me into retirement the end of October from her work with a subsidiary of Kollmorgen Corp.

"We are still in the same house in Baltimore that we have had for 28 years and have no plans to uproot ourselves in the near future. This year, so far, we have enjoyed a trip out through the southwest and a three-week sojourn (as usual) up the Maine coast. During the next year, we are looking forward to more travel now that we both have the time to do so. Our older daughter and family live about 25 miles from us, and our younger one and her family live on Long Island, so we see them all at reasonable periods."

A reservation deposit has been sent to the Mystic Hilton for our 50th reunion celebration. It is refundable up to a few months in advance. Keep the news coming, so it may be shared with classmates.—**Richard E. Gladstone**, Secretary, 1208 Greendale Ave., Needham, MA 02192

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Maxon H. King of Santa Cruz, Calif., sent a clipping from the *Santa Cruz Sentinel* about **Robert L. Sinsheimer**. He has retired after being chancellor of the University of California at Santa Cruz for ten years. Friends of Bob's have endowed a special chair in the UCSC Department of Molecular Biology. This endowment will allow the department to hire or keep top quality researchers or teachers.

Benjamin C. Scott writes: "After three years in the navy as a navigator and pilot, I worked for Chance Vought Aircraft (now part of the LTV Corp.) for three years, primarily in preliminary design. I also spent five years with Bell Helicopter, Textron in a similar capacity. I have been retired for five years, enjoying three children, four grandsons, and activities such as square dancing, golfing, swimming, archeological digs, and travel.

Nathanial Rochester writes: "I retired in June 1986 from a happy career in electrical engineering. During World War II, I designed radar equipment at, and later for, the M.I.T. Radiation Lab. I then designed computer hardware and software at IBM. At all times, I kept in touch with M.I.T. as a frequent visitor. For several years I was a visiting scientist and for one year a visiting professor.—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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Some more random notes from our super 45th reunion at the Woodstock Inn. **Lou Stouse** is still tilling the vineyards of AT&T Research in Greensboro, N.C. He is developing a special system for checking the contouring of the ocean's bottom. It is doubtful that Lou's work will do anything to improve my telephone service. . . . **Donn Barber** just retired from DuPont and did NOT become a consultant. . . . **Bill Johnson** sold his Newmet Co. in Connecticut to Krebsoge Corp. but is still running back and forth to Europe and is also running the company for the new owners.

Wonder if any of us knew that **Bill Foulkes** was one of a small group of researchers who got a special medal from Harry Truman for some of the early work on U-235? Bill is still at it as technical director of H.F. Technology, Inc. . . . **Art Marsh** joins the ranks of the retirees after being director of administrative services of RJR Nabisco Co. . . . Good to see Judy and **George Watters**, who jetted in from London for the Woodstock Bash. They won the prize for the longest trip to the reunion. I can't read the notes I made at the reunion, so please write in about your activities. . . . **Dick Meyer** became a member of the goodly group of '42ers who have served on the M.I.T. Corporation by being elected at its spring meeting. Congrats!

Only one obit this month. **Ted Nordin** died in Lynn, Mass. Ted worked for Douglas Aircraft, later for Battelle Memorial Institute, and in 1950 became head of his family's painting and contracting business. He operated it for 17 years, then went into the real estate business, from which he retired two years ago. We extend condolences to Mildred and to the family.—**L.K. Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

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By the time you read these notes, you may have received an announcement of the time and place of our 45th reunion. Present plans are to have it in Bermuda at the Stonington Hotel just prior to Technology Day 1989. It appears that an attractive rate may be available, and the committee is looking for a banner turnout.

Henry Bowes has been promoted to vice-president of the Lockheed Engineering and Management Services Co. Henry is responsible for the company's engineering and scientific support at the Johnson Space Center. He is a fellow of the National Contract Management Association. . . . **Lewis Tyree** retired at the end of July as executive vice-president and chief technical officer of Liquid Carbonic Industries. Lew has consulted to a number of major U.S. corporations and has over 35 U.S. patents. He has been working in cryogenic engineering since he left the Institute. He plans to move to his family home in Lexington, Va.

Your reunion committee met at the home of Marguerite and **Ed Ahlberg** on August 13. Present were: Jane and **Bob Barnaby**, Diane and **Andy Corry**, Jane and **Lou Demarkles**, and Ruth and **Norm Sebell**. The major topic was the location of the 45th reunion with the decision as reported at the start of this column.—Co-secretaries: **Andrew Corry**, Box 310, W. Hyannisport, MA 02672; **Louis Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

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Summer hasn't been a dead loss. A nice card from **Dick Dreselly** indicates he's moved from Augusta, Maine, to Brunswick—20 Cluf Bay Rd., 04011, to be precise. If you're in the neighborhood, drop in on him and Margery. Dick says they're planning to visit their daughter, grandsons, and son-in-law, who's a Colorado University professor in Boulder. . . . **Roger Sonnabend** sent regrets for missing the 40th and greetings from his home in the Florida Keys. If you haven't been in an isolation ward all these years, you know of Roger's Sonesta saga. He's been chairman and CEO for quite a while. His hotels are strewn around the U.S. and Mid-east, which keeps him on a busy travel schedule. He and wife Joan are into boats, art collecting, exercise, and family get-togethers. They have five daughters and two sons, all "very much career oriented." He says he'll see us at least at the 50th. . . . **John Filbert** is vice president and chief operating officer at Connecticut Natural Gas. He holds membership in AGA, New England Gas Assn., and Society of Gas Operators. Didn't see him at the 40th, and he's not in the bio book, but his LKA was Kensington, Conn.

So what about the bio book? Culling through our group of luminaries, I'm still finding interesting stories. Here's **Bob Goodstein**, a Brooklyn dodger who emerged from Course II and went on to get his M.S. and Ph.D. at Ohio State while teaching. Then he moved to Seattle to work for Boeing some 30 years ago, where he does his guidance and navigation magic on missiles and spacecraft. . . . **Tom Habecker**, a Course VIer who started out at the Naval Ordnance Lab outside D.C., went on to George Washington University to get a law doctorate, specializing in the patent process. After many successful years with the U.S. Patent Office, he retired six years ago (give or take) and moved to Oregon. Loves to work on his computer (don't we all?) and his farm, finding Oregon quite appealing. He and wife Maggie enjoy concerts and plays and Oregon in general. But of course!! . . . Then there's **Sheldon Hill**, a pre-med oddity (I think); he's not in the yearbook. After deciding doctoring wasn't in his karma, he got into architecture with a degree from the University of Illinois. After going to Europe on a travel fellowship, he opened his own office in Lake Forest. In 1971, Sheldon and wife Betty went around the world with nine other families related by involvement in the Institute of Cultural Affairs. This led to a year's sabbatical working with communities in Australia, Kenya, and Venezuela. He expects "to work until I drop." Sounds admirable, Tom.

Lots more goodies yet to come.—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

48 40th Reunion

E. Rudge Allen, executive vice-president and director of Fayes, Sarofim and Co. in Houston, was elected to the M.I.T. Corporation. The corporation meets four times a year and considers broad policy issues. It also operates 26 visiting committees, which provide critical counsel to each academic department and make recommendations to the corporation on academic activities and initiatives. Rudge has been a member of the Corporation Development Committee and was vice-president of the Alumni Association from 1983-86.

Denny McNear writes that he had lunch with **Dick Baum** and **Archibald Ferguson** in Phoenix. They discussed the 40th Reunion Gift and plans for the fun reunion in October 1988. They are interested in adding a fall color trip in New England before or after our October reunion.

James Brownlow retired after 33 years with IBM research. His work was mostly in ceramic materials and processing innovation. He was made an IBM fellow in recognition of his contributions. From 1948 to 1953, he was a key member of the group that introduced continuous-cast thin sheet ceramic dielectric products. He and his wife Jane live in Crompond, N.Y., and they have four children and six grandchildren.

Bob Crane continues with Sterling Drug as clinical project director in cardiovascular research after six years as director of clinical research. The biggest changes are greatly-reduced international travel and a move from New York City to Albany. Bob received an appointment as adjunct professor of biomedical engineering at Rensselaer Polytechnic Institute and will probably be involved in guiding graduate research dissertation projects involving medicine and bioengineering (his two non-M.I.T. doctorate degrees). Bob and his wife Jonny live in suburban Albany. For the prior six years, they lived in Manhattan, walked to work, and did not own a car. Now they have two cars, a larger home, fresh air, and a lot of greenery. Bob's son Ken and his wife live in Brooklyn. Bob's granddaughter is 1 year old, and Bob says the ride to Brooklyn is not too difficult, now and then.

Ed Mack is a senior research and development chemist at Craig Adhesive in Newark, N.J. His wife Elizabeth is enjoying improved health. Their son, Edward completed his second year at the University of Wisconsin. . . . **Paul Anderson** continues as vice-president and trust officer of Naumkeag Trust in Salem, Mass. He is a trustee of Phi Kappa Sigma fraternity at M.I.T. My family organized a surprise party for my 60th birthday. I was totally suprized when I arrived at the Barrington Yacht Club and found friends—some going back to high school days—M.I.T. classmates, relatives, children, neighbors, and business associates all gathered for the festive occasion. Adding to the happiness were Gloria and **Sonny Monosson,** Ginny and **George Clifford,** Ann and **Ken Brock,** and **Verity Smith.** A disc jockey provided the music for dancing the fox trot, and I enjoyed dancing with the ladies, women, and girls. Before I arrived they filled dozens of balloons and wrapped crepe paper on everything in sight. My birthday cake had the 60 candles that I had dreamed about.

Last year, **Joseph Fantone** of Needham, Mass. and **Walter Connell** of Manitou Beach, Fla. died. On behalf of the class, our sympathy is extended to their survivors.—**Marty Billett,** Secretary, 16 Greenwood Ave., Barrington, RI 02086

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There is a variation of Murphy's Law which says: "If you're following a list and there's an item you shouldn't miss, you will." I stumbled on this abominable rule last month when I failed to report that **Robert H. Sabel** and **Jack C. Tang** were on the list of those who received M.I.T. Corporate Leadership Awards last April. These are given to people who make exceptional contributions "to the continued strength and well-being of the economic system." Bob Sabel is vice-chairman of the Union Corporation in New York City, and Jack is chairman and managing director of the South Sea Textile Manufacturing Co. in Hong Kong.

According to the June 19 issue of the Harvard Gazette, **Francis M. Bator** has been appointed Ford Foundation Professor of International Political Economy. Professor Bator has served as Deputy National Security Advisor under President Johnson, as Senior Economic Advisor in the Agency for International Development, as special consultant to the Secretary of the Treasury, and as a member of the President's Committee on International Monetary Arrangements. He is the author of *The Question of Government Spending* and is a recipient of the U.S. Treasury's Distinguished Service Award.

When a man is about to retire, people ask: "What will you do with your time?" **Larry Collins** gave the matter deep thought and took action, to wit: shortly before retiring last March—He got married!—and for the first time! Not only that but he is now teaching *The History of Computers and Computing* and other courses at the University of Maryland in Silver Spring. So much for that question. The new Mrs. Collins is the former Dr. Jane Faulman who earned her Ph.D. in 1976 from the State University of New York at Buffalo. Welcome to the class, Jane! Larry has been a system analyst for the last 30 years at M.I.T.'s Lincoln Lab and at Mitre Corporation. "Hope to make another reunion sometime," he writes. Suggestion: try our 40th coming up in 1989. We'll save two places.

A personal letter from the indestructible **Bill Howlett** says he broke his leg in three places last June, but with a velcro and plastic cast on the ailing member went white-water rafting in July with his wife (and nursemaid) Eleanor. The previous fall, he spent a month in far western China. Snow-capped peaks rise to 12,000 feet in the region and, in a huge open-air market below, Bill and Eleanor enjoyed slurpies made from glacial ice shaved with a rusty bucksaw and colored with his choice from an array of bottles containing fluids about whose chemistry he was later dubious. Prosit! He and Eleanor have six daughters and seven grandchildren (rug rats, he calls them), all of whom are a joy. He mentions semi-retirement but also talks about being in the line function on only a couple of corporations now and what a pleasant change that is. Plus a consulting program which leaves him with a lot of bases to cover. In our heyday, Bill and I waited on tables together as members of the Student Staff at Walker Memorial. Neither of us ever broke a dish.

Another Lincoln Lab retiree is **Marvin Zimmerman** who is leaving after 35 years with the organization. He lives in nearby Lexington. On the phone I quickly found we agree that (1) civilization should be more civilized, (2) we know what's wrong with it, (3) all problems would vanish if people would just listen to us. Marvin has joined that select group, of which I am also a member, which finds that energy runs out before the work does. Nevertheless, he still toils part-time back at the lab designing electronic circuits. Right now the challenge is a detector circuit for infrared light. His two boys and one girl are out of the nest now, leaving Marvin and his wife with a house, lawn, and garden to keep up with.—**Fletcher Eaton**, Secretary, 42 Perry Dr., Needham, MA 02192; (617) 449-1614

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Our congratulations to two of the recipients of the annual M.I.T. Corporate Leadership Awards. **Roberto Rocca**, president of Organizacion Techint, and **John L. Roper III**, chairman of the board and CEO of the Norfolk Shipbuilding and Drydock Corp.

M.I.T. announced the appointment of **William H. Ramsey** as liaison officer in their Industrial Liaison Program. William was most recently a vice-president for an electronic manufacturer of power sources in Minneapolis. He had previously been a consultant and manager for M.I.T., Sperry, RCA, and Sanders Associates in electronic programs.

Rennsselaer Polytechnic Institute recently conferred an honorary doctor of science degree upon **Howard E. Simmons**, vice-president of Dupont's Central Research and Development Department. RPI recognized his "key leadership in developing major new programs in molecular modeling and biotechnology." In addition, he "further distinguished himself through his own research on theories of complex molecular geometry." Howard became director of the Central Research and Development Department in 1979 and assumed his current position in 1983. He was elected a member of the National Academy of Sciences and the American Academy of Arts and Sciences in 1975, is a fellow of the American Association for the Advancement of Science, and the New York Academy of Sciences. He and his wife Elizabeth live in Wilmington, Del., and have two sons.

From La Jolla, Calif., **John C. Monday** writes that he is chairman and president of Specialties Engineering Corp. of San Diego. He has been for 19 years a director of Intermark, Inc. of La Jolla. Jack has two children, a stepson, and four grandchildren.

Sadly, we have received word of the passing of **Mihran Ayvazian**. We extend our condolences to his brother and their family.

I am still sending some of my waning supply of the class statistics from last year's reunion to those of you who will trade them for a few lines about yourself and your family.—**Martin N. Greenfield**, 25 Darrell Dr., Randolph, MA 02368

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Yaichi Ayukawa, who has been a member of the M.I.T. Corporation since 1977, was elected a life member last June. Dr. Ayukawa received a degree in industrial microbiology from Tokyo Imperial University in 1945, and the S.B., S.M., and Ph.D. degrees in food technology from M.I.T. He has been president of Techno-Venture Co., Ltd. since 1975 and is a director of several Japanese and American companies, among other activities. **Herbert Dow** and **Joe Moore** are other classmates who serve as members of the corporation.

Jack Larks, a consultant in forensic safety engineering in Houston, attended our recent 35th reunion and noticed "how everyone else has matured (euphemism for older) while I'm the same happy-go-lucky kid." I am sure most of us feel that way, too, part of the time at least. With the proper lighting, some might even look it. Jack says he was sorry to learn that Charlie the Tech Tailor was retiring and going out of business. Ah yes, as we all know, change is not always progress, and the loss of a landmark leaves us a little disoriented.

The May issue of the house newspaper of the Charles Stark Draper Laboratory carried a picture, suitably lighted, of **Mike Sapuppo**, Instrument Development Department head, chairing a session of a conference on contamination control in the production of inertial guidance systems. It seems that dirt in an inertial guidance system is even more disorienting than the loss of the landmarks of our past.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

53 35th Reunion

Fortunately, we have been inundated these past two months with news from and about our classmates, probably because everyone is beginning to think about Tech and our 35th class reunion in June. **Fred Brecker** certainly is, and he's written a long letter about the reunion and added some news. So that all of you can do some advanced planning, I'll summarize what I know about the reunion weekend. It will start at the M.I.T. campus on Wednesday afternoon, June 1, or Thursday morning. Thursday evening there'll be a buffet dinner followed by Tech Night at the Pops. Technology Day is Friday, and then we will have class events (to be determined) on Friday and Saturday night. After Sunday brunch, plans are to stretch our reunion to three nights more on Nantucket Island. By now, I hope everyone has already received a flier with more details about the planned activities. Also, if you would like to volunteer to help with the reunion, it's never too late!

Fred writes that he received a call from **Jay Berlove**, who has been in business with **Howie Stern** since our last reunion. Fred was also at a wedding dinner with **Dick Linde**, who is still working at Western Union in New Jersey, and **Fred Cronin**, who has a computer hardware business in Danbury, Conn. Fred Brecher's son Neil is a freshman at Boston University, so Fred expects to be coming to the Boston area more often.

A note from **Tollyn J. Twitchell** tells us that he's still practicing architecture in Sarasota, Fla., but he has a sideline activity in the mobile home industry and is chairman of the Florida Park Owners Association. He is "happily remarried" (his words) to the former Robina Magee, and his son Jeff and daughter Carol both received their doctorates this year. Congratulations to all of you.

Richard E. Storey informs us that he has retired to Vista, Calif., from Lockheed after 30 years in industry and is enjoying a full life in retirement. Also, **Ray Sauer** writes that he is working for Alcoa in Pittsburgh, where he is manager of product safety and reliability.

An article from the Charles Stark Draper Laboratory (CSDL) company paper provided a little news about Dr. **Ed Kingsbury** of the CSDL Bearing Center. He recently conducted a seminar at the 1987 Instrument Bearing Symposium on ball-bearing technology. Also, in April, M.I.T. conferred Corporate Leadership Awards on 64 alumni, one of whom was our classmate, **Thomas J. Perkins**, who is chairman of Tandem Computers, Inc. Another ceremony at the Institute honored two of our classmates who have both recently retired from M.I.T., **Jack B. Dennis** after 32 years as professor of electrical engineering and computer science, and **Nelson C. Lees**, who worked in Resource Development, after 28 years of service.

After all of the good news above, I'm sorry to have to add a sad note, but I have received notice of the death of four of our friends. **Howard F. Rockstrom** passed away just before Christmas 1986. He lived and had a business in Carlisle, Mass. Also, I just learned that **Hajime Yoshii** of San Jose, Calif., passed away in February 1986. No other information is available. More recently, **George A. Wallace, Jr.** died in his sleep in April at his home in Cape Elizabeth, Maine, at the age of 59, having retired in 1980 as senior vice-president of Olin Corp., Stamford, Conn. Most recently, **William G. Blanding**, also 59, died on May 3 after a brief illness. A Fulbright Scholar at the Norwegian Institute of Technology before coming to M.I.T., Bill was operations manager with Manta Marine Corp., also of Stamford, Conn. Our sincerest sympathy to the wives and families of all of them. They will be remembered fondly by many of their classmates.

To end on a happier tone, Audrey and **Joe Cahn** have announced the birth of their first grandchild to their son David and his wife Jana, who together "cooked up," as the announcement says, one baby girl, Sara Rebecca Cahn. Joe and Audrey have now joined the ranks of the rest of us doting grandparents.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701

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Very little class news has reached Connecticut recently, so these notes will be short. A brief message from **Ray Rivero** informs us that he is now president of Ray Rivero and Associates, Inc., a growing management consultant firm with a professional staff of six. Ray lives in Irvine, Calif. . . . And we are very sorry to have to report the death of **George Rivers**. No information is available except that he died last May.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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Samuel S. Friedman is now director of CCX, Inc., Carle Place, N.Y. Previously he was attorney-partner for Lord, Day & Lord, New York, NY. . . . **Ronald B. Goldner** provided the article, "Electrochromic 'Smart' Windows," for *The Reflector* magazine, May 1987. By using thin solid film layers, which are being developed under his direction at Tufts University Electro-Optics Technology Center, the U.S. could save $30-50 billion annually. After receiving his B.S. and M.S. from M.I.T., he received his Ph.D. from Purdue University. Ronald was a visiting professor at M.I.T. and the University of Arizona prior to his co-founding the Tufts Electro-Optics Technology Center. . . . **Norman Siegler** has been appointed vice-president, financial administration and CFO (assume chief financial officer) at Dana Computer, Sunnydale, Calif. Dana is in the development stage for a single-user supercomputer, an engineering and scientific work station. Norm works the normal/ridiculous long hours of start-up and loves it. He moved to California in 1983 with his wife of 32 years, Marlene; they live in Saratoga. They have four children; their youngest son, Eric, graduated from M.I.T. with a S.B. and M.S. in mechanical engineering in 1985.

Bob Hoedemaker suffered brain damage and has become incapacitated and unable to talk as a result of a freak accident while playing handball, which he routinely engaged in several times a week to keep fit. A tax deductible fund has been established—"Bob Hoedemaker Fund," P.O. Box 269, Belle Mead, NJ 08502—to obtain a lift van and to cover staggering expenses not covered by insurance. Bob worked at RCA's Astro-Electronics Center in West Windsor building and testing weather and communication satellites and was active in Mongomery Township activities. Any funds or correspondence will be appreciated. We were made aware of this situation by Eduardo L. Elizondo '55, East Windsor, NJ 08520, who is a friend and colleague of Bob. Bob's wife is Joan.

Life's accomplishments do include home and family. **Bruce Bredehoft**'s wife, Mary Ann, was the feature of a *Christian Science Monitor* article of March 17, 1987, "Knitting Goes High Tech." Mary is involved in the Knittin' Kitchen of Cambridge, Mass. . . . **John A. Morefield, Jr.** referred us to a May 17, 1987, Sunday *Washington Post* magazine article, which caught his attention because it referred to **Craig Sherbrooke**, his family, and primarily his son Evan, who is to be featured in several articles. "I congratulated Craig and his wife Rosalie on the fine example their family has set for others by their accomplishments," says John. This secretary agrees with John, and the articles are worth the reading; they related to the liability of being intelligent.

A rewarding Thanksgiving and happy holidays to you all.—Co-secretaries: **George H. Brattin**, 39 Bartlet St., Andover, MA 01810, (617) 470-2730; **Irwin C. Gross**, Sweet's McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

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Ralph Warburton was recently elected a fellow of the American Institute of Architects. . . . **Vic Klemas** was appointed by the National Research Council to the Space Applications Board of the National Academy of Science. Dr. Klemas was also appointed director of the Applied Ocean Science Program at the University of Delaware, and he has been elected to the editorial board of the *Journal of Coastal Research*. . . . **John Psarouthakis**, chairman and president of JP Industries, Inc., was the recipient of an M.I.T. Corporate Leadership Award this past spring. The award honors individuals whose responsibilities in private industry mark them as exceptional contributors to the continued strength and well-being of the economic system. M.I.T. President Paul E. Gray, '54, and David Saxon, '41, chairman of the M.I.T. Corporation, presented inscribed Paul Revere bowls to the recipients.—**Vivian Warren**, Secretary, Anasville Rd., Somers, NY 10589

58 30th Reunion

Last issue before the official start of the Year of the Reunion! By now, we hope you've made your plans to join your classmates and friends for the festivities at the good ol' Harbor View in Edgartown. Lots of sun, sand, sailing, sports (submarine races?), scenery, spectating, and seafood.

Ahhh, the seafood! The Harbor View is famous for its shore dinner and clambake.

Toni Schuman visited with Nancy and me when she was in Boston in June. Toni's daughter, Jennifer, has just completed a year's study at the M.I.T. School of Architecture. . . . Among those receiving the M.I.T. Corporate Leadership Awards this year was **Leonard Simon**. He is chairman of the board and CEO of Rochester Community Savings Bank.

Unfortunately, we just received a belated notice from Hawaii that **William Veeck** had passed away in early 1985. Bill had received his M.A. in mathematics at Arizona State University just before heading to the Islands in 1964. Most recently, he was teaching at Kauai Community College in Lihu, Kauai. Bill was especially proud of his family, and we extend our sympathy to his wife, Mary, and their two children, Valerie and Raymond.

Think Reunion! See you next issue.—**Michael E. Brose**, Secretary, 841 Magdeline Dr., Madison, WI 53704

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Brian R. O'Connor writes that E.I. DuPont Electronics has named him regional director for Asia and the Pacific. After September 1987, Brian and his wife Linda will be making Tokyo their home and "looking forward to one last fling" before they retire (as unbelievable as it seems for youngsters like us, there will be more and more news of and planning for retirements in the next few years).

Adding an honorary doctor of science from Lawrence University, Appleton, Wis., to her already long list of achievements, **Sheila Evans Widnall** was also a commencement speaker at Lawrence. Sheila is Abby Rockefeller Mauze Professor of Aeronautics and Astronautics at M.I.T.

Three members of our class were among 64 alumni given M.I.T. Corporate Leadership awards by David S. Saxon, chairman of the M.I.T. Corporation. The award honors those alumni who are chairman, president, or hold other high positions in industry and business. Our congratulations go to **Patrick J. McGovern, Jr.**, chairman and CEO, International Data Group; **John W. Norris**, president and CEO, Lennox Industries; and **John W. Poduska**, chairman, Apollo Computer. Our best wishes for continued success to the three honorees.

Walter Godchaux III tells us that he is associate professor, Department of Molecular and Cellular Biology at University of Connecticut, Storrs, Conn. Walter's research is on "mechanism of bacterial gliding motility and role of unusual lipids therein," and is being sponsored by an NSF research grant. . . . Another indication that time marches on comes from **Howard I. Braun** in Clearwater, Fla., who reports on the June 28 marriage of his son Richard. . . . A recent weekend gave me the pleasure of visiting with **Abe Feinberg** and his lovely wife Vickie. Both Abe and Vickie are on the faculty at California State, Northridge; Abe also is on the staff of Jet Propulsion Laboratories.

This edition of the class notes marks the debut of your new class secretary. In a moment of weakness, and not even being plied with strong drink, **Pat Coady** convinced me that I owed it to the class to take over the duties of both class secretary *and* class agent. We all owe Pat a vote of thanks for his diligent efforts. I hope I can do as well. My only request as I start my endeavors is that you be generous with both your words and dollars. It will make my jobs a lot easier.—**Frank A. Tapparo**, Secretary, 15 S. Montague St., Arlington, VA 22204

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Do you wish you had gotten better grades in 8.01 or 6.214? Do not despair. How about Dean's list for eight straight terms? It can be done. It's really simple. Just call **Dave Wiley**, who is now M.I.T. registrar, and ask for a small favor. His strong background in theoretical physics (Ph.D., Princeton, 1966) will certainly help him in this difficult position. I know he will be glad to assist you in any nefarious project that will advance your career.

I have quite a bit of mail from physicists this month. **Robert Hofland** says he has been head of the High Power Laser Department at the Aerospace Corp. in El Segundo, Calif., since November 1984. He has also been singing (tenor) in the L.A. Opera Co. in "Tosca," "La Traviata," etc. . . . **Ron Roccio** writes, "After spending a year teaching medical physics in Taif, Saudi Arabia (the summer capital, 6,600 feet up in the mountains near Mecca), I took the next year off. I went on safari in Africa, drove through Egypt and much of Europe. Then, I bought a round-the-world ticket. I visited many countries but spent most of my time on beaches in Bali and Thailand, and trekking in the Himalayas of Nepal. Currently I'm working in New York and planning my next trip."

Donald Morrison is leaving New York next year after 22 years at Columbia University. He's off to UCLA where he assumes the John E. Anderson chair in the Graduate School of Management. It's a smart family. His wife Sherie got a professorship at UCLA, too, hers in microbiology. The Morrison's daughters are on the other side of the podium: Michele a freshman at Boston University and Heather a senior at Stanford. . . . **Irwin Sobel** writes, "I'm doing computer integrated manufacturing at Hewlett-Packard Labs. My wife Ceevah showed paintings at the San Mateo Arts Council last year. Daughter Sarah is in third grade and does gymnastics, art, and acting."

John Sununu is gathering steam to run for a fourth term as governor of New Hampshire in 1988. John is now chairman of the National Governors Conference, and there is talk that he has national ambitions. One possibility seems to be a cabinet post if George Bush manages to become president. . . . A note from M.I.T. says that **John Deutch** has become a director of Citicorp in New York. It's just a coincidence that **John Reed** is CEO at the same place. . . . **Richard Span** is another new director—this time at Visage, Inc. in Framingham, Mass.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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Class treasurer **Tony Mack** sent me a column by **Scott Burns** from the June 21 edition of *The Dallas Morning News* with comments on the most significant changes that Scott noted about student life at M.I.T. The revolution in computer technology from our days of the IBM 704, 709, and 1620, when 64K of computer memory cost $2 million, to the home computers of today with 256K for less than $1,000 led the list. The significant increase of women in technology, from the 15 women members of our graduating class to 29 percent of the current M.I.T. undergraduate enrollment and 20 percent of graduate enrollment, was another change of note. Some of us remember that we had bi-annual "riots" concerning tuition increases of $200 per year—from $1,300 when we entered to $1,500 when we left (and the announced increase to $1,700 the year after we graduated). Scott points out that current tuition is now $11,000 per year, about eight times higher than when we were there. And with starting salaries having increased only about fourfold, the relative cost of an M.I.T. education, as well as the payback on that education, have deteriorated with the years. Scott's purpose in all this, besides the nostalgia we share, is to promote the concept of increasing the productivity of education. Now if we can just come up with some effective ideas on how to do this without alienating the students by further separating them from their teachers, we might have something better than videotaped highlights (TV courses) and computer-friendly self-instruction. Yes, classmates, most students would like more personal contact with real, live teachers with whom they can interact on a creative (synergistic?) basis (at least that has not changed since our days at M.I.T.), and there's the essence of the productivity problem.

Miniature books (above displayed by Anne Bromer) are a specialty item of Bromer Booksellers in Boston. In 1977, David Bromer, '62, left his job to join the rapidly expanding family business which had begun from his wife's hobby, rare book collecting. Among the books on display at the Bromers' gallery are a first edition of* Huckleberry Finn *signed by Mark Twain, a deluxe limited Richard Meryman edition of Andrew Wyeth's greatest works signed by the artist, and a first edition miniature volume of Shakespeare's newly discovered poem "Shall I Fly," which the Bromers published themselves.

Tony Mack reports that the final tally for the 25th reunion was 150 actual classmates including two double entries of husband and wife. I stand corrected from last column, since both Emma and **Steve Root** and Susan and **Lynn Whelchel** were there.

M.I.T. informs us that classmate **Sherwin Greenblatt**, president of BOSE Corp., was honored with other M.I.T. alumni this past spring with an award for distinguished corporate leadership. This award honors individuals "whose responsibilities in private industry mark them as exceptional contributors to the continued strength and well-being of the economic system."

Further notes from the reunion. **Bob Hirschfeld**, who most of us remember as the editor of *VooDoo*, came from Phoenix, Ariz., where he is now a practicing attorney working for single fathers' rights and occasionally helping inventors to get patents. If you need experienced advice on how to raise a family as sole custodian, contact Bob in Phoenix. . . . My old roommate, **Manny Terezakis**, came up from Rhode Island for the party with his wife, Annaken. Manny is now a full-time chemistry professor in the Rhode Island

Community College system. . . . **Ben Gunter** came from Shaker Heights, Ohio, where he is senior project manager/systems consultant with Sedlak Management Consultants, specializing in distribution systems and automated warehouses. Ben has just about finished his Ph.D. in systems engineering at Case Western Reserve and spends his spare time with church work, orienteering, and teaching himself Latin. . . . **Terry Bray** came up from Austin, Tex., where he has been more successful than John Connally in real estate ventures. Terry is a law partner with Graves, Dougherty, Hearon and Moody in Austin, and is quite involved with the various Bar Associations (legal not booze), and civic groups.

We'll keep the reunion data file in motion for future columns as I wait to hear more from you directly down here in the "Heart of Dixie."—**Henry N. McCarl**, c/o McCarl and Associates, P.O. Box 352, Birmingham, AL 35201-0352

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We've got skinny pickin's this time, as usual with notes provided by you-all over the summer. I am pleased, however, to report honors received by three of our classmates. (Each was too discreet to relate his good fortune directly.) **John K. Castle**, who has bestowed significant financial benefit on the Institute in the past—sharing the rewards earned by his astute financial management—has been elected a member of the M.I.T. Corporation. He will serve five years. John was one of twelve persons so recognized. Others in this lofty league include the retired chairman of Gulf Oil and current chairman of Standard Oil of Ohio.

A different type of distinction came to **Gary Jensen**. He is co-author of *Differential Systems and Isometric Embeddings*, published in May by the Princeton University Press. The book, available in hard and soft covers, is first in a series to be called the William H. Roever Lectures in Geometry. Congratulations, Gary, for making it into print in such an august fashion.

It was reported that **Stephen Benton**, who graduated with us in electrical engineering, has been made Professor of Architecture at M.I.T. He has worked extensively in white-light holography, and invented the Rainbow Hologram (also called the Benton Hologram). He has recently produced the first project-image hologram from a computer database, a process holding promise for medical imaging and CAD.

Kindly send (or phone) some notes, please.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218; (301) 889-3890

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I regret to report the death of **Dennis Hinrichs**, who passed away in May following a lengthy illness. After graduation, Dennis served in the U.S. Air Force for four years. He received an M.B.A. from Boston University in 1972 and was financial comptroller at the Cambridge Systematic Co. for the last 16 years. Dennis is survived by his wife Margaret, his parents, and his sons Stephen, Brent, and Jonathan. At the time of his death, he was a resident of Nahant. Our condolences go out to his family.

Glenn Stith writes that he has been recently transferred from Amoco's research center in Naperville, Ill., to Amoco's Chicago Data Center. He is now manager of center technical services and user support. Glenn, his wife Susan, and daughters Shannon and Heather are still living in Wheaton, Ill. Shannon and Heather are a high school senior and sophomore, respectively.

Jack Moter, who captained both the basketball and tennis teams while he was at the Institute, has become president of the New England Tennis Association. . . . **Jon Gruber**, who had been with Montgomery Securities in San Francisco, has gone out on his own and set-up Gruber Capital Management, a money management company located at 909 Montgomery St., San Francisco. Their first investment partnership for individuals has closed, with $75M under management. Jon notes that his involvement with Montgomery Securities was "quite a fun experience"—they went from an unknown 15-20 employee firm to a "real powerhouse" with revenues of almost $100M and 400 employees.

Louise and I are in the final stages of planning an early fall college visit trip with Jennifer, our elder daughter. No career-oriented selection process for Jennifer—her criteria are "someplace warm" and "mid-size (4,000-6,000 students)." Best wishes of the holiday season to each of you. Please send some news of your lives.—**Joe Kasper**, Secretary, 3502 Idaho Ave., N.W., Washington, DC 20016

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This must be what they call the summer doldrums. Actually not enough news for that even; maybe just a doldrum. Funny how some words are never used in the singular. But I digress . . .

Gary Rose has been promoted to president of Icarus Computerized Consulting Services, Inc. on Long Island. . . . **Pierre Perrolle**, who must have one of the most interesting jobs in the class, writes that he is currently serving as science and technology counselor at the U.S. Embassy in Beijing. He's continuing his work of the past decade, building up science and technology cooperation between the U.S. and China and, incidentally, greatly increasing his fluency in Chinese!

But one paragraph of news for late summer (this is written in August). Maybe the letters will pick up as classmates get back to work in the fall.—**Steve** Lipner, Secretary, 6 Midland Rd., Wellesley, MA 02181

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Don Haney received two promotions in June: to Lieutenant Colonel in the Air Force Reserves (he's working as an engineer at Kelly Air Force Base) and to associate professor of computer and quantitative management in the School of Business and Administration at St. Mary's University in San Antonio.

Jon Burkhardt is working hard to organize the tenth American Kitefliers Association Convention at Dulles Airport in October. He says that both engineers and artists would be fascinated. John has two kids in college.

A note from class president, **Stu Vidockler**, indicates that he has left his three year stint as budget director for the City of Boston, leaving the city with its first surplus in 11 years. Judging from the letterhead, it appears that Stu is now a vice president at Salomon Brothers in New York, unless he's using somebody else's stationary.

Alan Dinner is now director of product development and pharmaceutical regulatory affairs at Eli Lilly & Co. By now they should have both a new home in Indianapolis and a second child. . . . Michael Rinaldi continues to work at GE in Lynn, Mass., making aircraft engines. He is currently manager of systems and manufacturing development. **Thomas B. Jones** left Xerox "after 3 interesting years" to accept an appointment in the electrical engineering department of Rochester University. He writes that the return to academe has been most enjoyable. . . . **Peter Young** is still working for the Southeastern Pennsylvania Transportation Authority, and playing the organ almost every Sunday in various churches.

Dr. **R.D. Camerini-Otero** is chief of the genetics and biochemistry branch of NIH in Bethesda, MD. He is doing research on molecular genetics. His wife Carol is also a researcher at NIH. They have two children: Danny (6) and Sarah (2).

Not a lot of news notes this month, so please send some news of how you are all doing.—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

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Daniel Corwin has been busy running Lexikos Corp., an advanced intelligence start-up company whose software translates English documents into files that can be analyzed by expert systems or used to help build them. . . . **Ray Ferrara** has been named manager of advanced development in the application engineering group at Digital. Also he proudly announces the birth of his second son, Gabriel, on January 7, 1987. . . . Following our class reunion in June, Jane and **Ron Casseres**, who live in the Netherlands Antilles, spent several days vacationing and visiting ten prospective colleges with their oldest son Marc. Perhaps like many other classmates, Ron and Jane are planning to make it to our 25th if they have any money left after college expenses. Sharlotte and I spent two days with them on Nantucket Island after the reunion and enjoyed it immensely. We also vowed to keep in touch and not let so many years go by without getting together.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

68 20th Reunion

Help! Only two items in our very lonely mailbox this month. How swiftly we go from feast to famine. However, in accordance with our determination not to miss any more months for the class, and since the first item is rather unusual, we'll report on what we have.

Technology Review fowarded to us a fascinating clipping from the Portland, Maine, *Evening Express* about **Patrick Haynes**, a professional masseur. Patrick, the article reports, had a massage one day and "it made him feel so wonderful, he stopped being a hydroelectric engineer and became a licensed massage therapist." As a result, he and his wife, Ann, now run the Portland School of Massage Therapy. He has trained about 13 of the 30 practicing massage therapists in the Portland area, and also holds seminars for the general public.

Rick Rudy writes that he has been made manager of quality assurance and regulatory affairs for Laserscope. He also has been re-elected president of the High Tech Gays and is writing a theater review column for a local paper.

As for ourselves, we seemed to spend more time than usual this past summer cruising the Chesapeake Bay in our sailboat, *Silver Girl*. Even after 15 summers on the bay, it hasn't lost its charm.

We class secretaries are enjoined from discussing world events or philosophy in these columns, so if we don't hear from more of you soon, the class of '68 will be back among the missing next month. With our 20th (it can't really be!) reunion coming up in June, these next few months would be a great time to hear from some of you who haven't checked in for quite some time.—**Gail** and **Mike Marcus**, Co-Secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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There is a hint of autumn in this New Hampshire August as I gather together these holiday season notes. . . . **Michael Neschelba** became the assistant scoutmaster of his son's troop in Acton last year and is now getting plenty of fresh air as he camps with the boys. Michael has been with Polaroid for 16 years and is presently in operations management. . . . **Carl B. Everett** spent 12 years in Dupont's legal department, but he has now joined Liebert, Short, Fitzpatrick, & Hirshland in Philadelphia, where he specializes in environmental law. . . . **John M.L. Gruenstein** writes from LaFayette, Calif., a suburb of San Francisco, that he, his wife Carolyn, and three kids—Cassie (12), Alex (7), and Elizabeth (2.5)—"flipped coasts" last year. He says, "We're working hard at being laid

back." He is director of public information, an economist and vice-president, at the San Francisco Fed. He looks forward to getting involved with M.I.T. activities in the Bay area but finds little time at night. "How about noon in SF?"

A clip from the North Adams, Mass., newspaper is headlined "Growth can bring controversy, but consultant takes it in stride." The consultant with Connery Associates of Winchester, Mass., is our own **Michael Oman**, who is helping N. Adams cope with an array of growth issues such as traffic problems, low income housing, and zoning changes. In a concluding quote he says, "If I can be part of a process in which the town has reached some big decisions about itself and come back in ten years and look at a town that's really doing well and say 'I was a part of this'—I like that." That takes care of the notes hopper this month. Any of you who see the National Academy of Sciences magazine, *Issues in Science and Technology*, will see a forcefully argued (pro) piece by me about the search for extraterrestrial intelligence in the Sept./Oct. issue. For an encore, I just completed the exhausting task of indexing my book, *The Quickening Universe*. Hope that some of you will glance at it as you rush around doing holiday shopping.—**Eugene Mallove**, 183 Woodhill-Hooksett Rd., Bow, NH 03301

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Julia Norton is a professor of statistics at the California State University at Hayward. She writes that she has three children and is looking forward to the 20th reunion. . . . **Jeffrey Sagarin** has developed the computer rating system for college football and basketball that appears in *U.S.A. Today*. He is also one of the creators of a computer basketball game called "HOOPS." He is residing in Bloomington, Ind. . . . **Robert C. MacCready** has been promoted to the position of corporate controller of Town & Country Jewelry Mfg. Corp. in Chelsea, Mass. He will have international responsibilities for financial reporting, regulatory compliance, and development of financial procedures for all of the corporation's subsidiaries. He lives with his spouse Linda, in Newton.

Robert A. Swanson, CEO of Genentech, Inc. has recently been honored by M.I.T. for distinguished corporate leadership. . . . A letter from **Steven F. Cooper** indicates that his specialty is anesthesiology. He practices in the Sherman Oaks area of California. He wanted everyone to know that **Larry Griffith** got married in May.—**Robert Vegeler**, Secretary, Beers, Mallers, Backs, Salin & Lamore, 2200 Ft. Wayne Natl. Bank Bldg., Ft. Wayne, IN 46802

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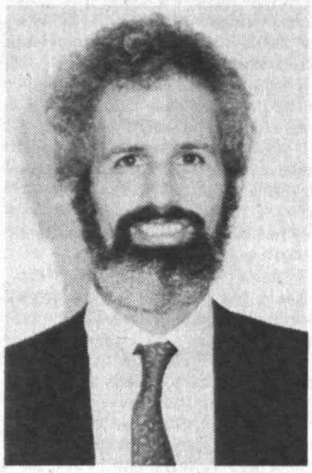
Ed Buchak and his wife, Bonnie, are the proud parents of Gregory, born December 30. . . . Betsy and **John Dieckmann** had their third child and third girl near the end of February. . . . **Thomas H. Derby III** (now classified as a '71er) directed the Atlanta Personal Solicitation Visit Program for 1986-1987. He is a full-time independent consultant, spending one-half of his time providing marketing services to firms selling technological solutions to hospital executives and one-half time providing energy management services to large commercial buildings and institutions.

David J. Sales, M.D., is chairman of Gastroenterology at Northwest Community Hospital in Chicago's northwest suburbs and is on the associate faculty of University of Chicago. He and his wife Charlene are the proud parents of Adam (5) and Benjamin (1). . . . **Reid Ashe** is president and publisher of the *Wichita Eagle*. Reid joined KnightRider, Inc. in 1984 as a general executive and served as chairman and CEO of Viewdata Corp. of American, a KR subsidiary operating Viewtron. . . . **Bruce W. Wheeler**, assistant professor of electrical and computer engineering at University of Illinois, Urbana-Champaign, has been selected as one of the recipients of the Stanley H. Pierce Award, an award given annually to faculty members who have done the most to develop empathetic student faculty cooperation. In addition to his S.B. and M.S. from M.I.T., Bruce holds a Ph.D. from Cornell.

Robert Hazen and his wife Margaret have written *The Music Men: An Illustrated History of Brass Bands in America, 1800-1920*, published by the Smithsonian Press. The book explores the evolution of the American band movement from its beginnings in the early 19th century to the end of World War I. Robert is a staff experimental mineralogist at the Geophysical Laboratory and a professional symphonic trumpeter. Margaret is a professional researcher, librarian, historian, and writer on subjects as diverse as songs of Revolutionary America and the history of the American minerals industries. Their collection of band miscellany now forms the nucleus of an archive of American band history at the Smithsonian's National Museum of American History.—**R. Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

Energy Expert Turns to Big Water Problems



Paul F. Levy, '71, who cut his teeth in public service as chairman of the Massachusetts Department of Public Utilities, now has a big new job: he's executive director of the Massachusetts Water Resources Authority, created two years ago in response to a federal court's order that the state end the pollution that has made Boston Harbor the nation's dirtiest.

In addition to managing Greater Boston's waste water, Levy's agency is responsible for water supply and distribution to Boston and many nearby communities.

Accordingly, at a mid-summer press conference when he was designated to become MWRA executive director, Levy announced a three-point program:

☐ Push for water conservation as the primary means of meeting Boston's future water needs. He proposed specifically that building codes be changed to require water-efficient fixtures and that water distribution systems be improved.

☐ Build the new waste treatment facilities that will be needed to "repair decades of neglect in Boston Harbor." The cost of this major engineering assignment may go as high as $3 billion.

☐ Educate the public to understand that "we are all part of the problem and of the solution." This would include helping communities with technical assistance, including modernized billing for water and sewers, and creation of a water museum. "There is no reason this authority should be viewed as a bad guy," said Levy, "and yet it has that image."

Levy's M.I.T. degrees are in economics (S.B.) and urban and regional studies (M.C.P. '74), and he has gained generally good marks for his service as public utilities chairman since 1982.

Levy's planning expertise was tested almost as soon as he took the MWRA job, when his agency sought to acquire a Quincy site as a staging area for harbor waste treatment construction. The city of Quincy took MWRA to court to prevent this use of the land, while the U.S. Environmental Protection Agency threatened more legal action to keep the harbor cleanup on schedule. ☐

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After a civil engineering Ph.D. from Princeton and work for two engineering consulting companies, **Gary Chirlin** formed Chirlin & Associates, Inc., which specializes in groundwater hydrology and contamination with emphasis on data interpretation, remedial planning, and water supply issues. He and his wife Kristi have two boys—Daniel (6) and Michael (2), "both independent spirits and unending joys." . . . **Charles Gronauer** was chairman for the 1987 Florida Magicians Association Convention in May. At work he is systems manager for a Sigmagraphic C.A.D.D. Computer System, used for architecture production drawings.

John Yee writes to report the birth of his second daughter Susan on May 20. He and his wife Sandra live in St. Catherines, Ontario, and he works for Agriculture Canada (the federal government's agriculture department) at the nearby research station. . . . **Janet Saul Lantner** writes with her excuse for not getting to the reunion: "After

three, count 'em, three, masters, I finally finished the requirements of a terminal degree. I received a Ph.D. in engineering from UCLA. It was undesignated, but my major field was physical metallurgy. I will continue to teach at the University of Houston. Yes, I have been in Houston for three years, and my degree is from UCLA. I think I get the award for the longest commute. My husband Gary was named vice-president of Eastern Airlines recently."

Simon Wieczner has started working for himself doing publishing and marketing consulting. He has a first child, a daughter. . . . **David McDonald** says the Chinese curse is living up his life. "Political differences with key department members and a lack of planning has gotten me denied tenure at University of Massachusetts, so I'm going to spend a year with the software company I helped found (Brattle Research in Cambridge, an artificial intelligence software company) while looking to see if interesting professor jobs crop up at another university. . . . **James Lowe** is ranching and farming 2,500 acres of prime Nebraska sandhills with his wife Jo and two sons, Justin and Jason.—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

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It's the off-season for letters; there are none to report and only a pair of blurbs to pass along, so two of you get all the attention. . . . **Donald Garvett** has been promoted to vice-president of revenue management for Pan American World Airways. . . . **Lisa Klein** has been promoted to professor of ceramics at Rutgers University. She received the Schwartzwalder-PACE award from the American Ceramic Society for significant achievement by a young ceramic engineer.

No "significant achievement" here to report; kids are fine, we're healthy, same job, no checks from letters with Ed McMahon's picture on it. Yet.—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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First is a call for a little networking from **Harry Psimarnos**, who's looking to contact people in the marine industry. Harry notes his own 25 years experience in the Merchant Marine, including ten years in the passenger ship industry. Any old salts out there? . . . **Fred Shapiro** has been appointed assistant director of the Yale Law School Library; he's continuing as adjunct associate professor of law at New York Law School; he and wife Jane and son Andy are moving to New Haven; and he's got a book coming out late in the year. . . . **Gregory Turner** writes that his three-year-old architectural practice is growing, as are his sons Matthew and Alan. Gregory and Ann live in Houston. . . . From Mission Viejo, Calif., comes news of **James Falk**, now plant manager for LNP Engineering Plastics. . . . **Barry Alan Zack** formed a consulting company, Pantech Systems, specializing in knowledge engineering and expert systems. Barry lives in Derry, NH.

On the baby front, **Judith Fallows** and **Adrian Gropper** welcomed son Zachary into this world in November 1986. . . . **Fred Sears** is expecting his first child in September. Fred's a member of the technical staff at Bell Labs in Georgia. . . . A second daughter was born to **Robert Batzinger** in April. Robert resigned his position as dean of science at Payap University to start a consulting firm for electronic typesetting and desktop publishing in non-roman scripts.

The Most Varied and Interesting News Item of the Month Award goes hands-down to **Everett Shareck**. Everett finished three years as a family practitioner for the U.S. Public Health Service in St. Thomas and moved to San Francisco. From there, he supervises an emergency room near Lake Tahoe two-to-three times a month. He has finished a book on learning to read Japanese kana in eight hours, and he's presently working on a medical mystery novel about post-feminist reproductive technology.

Class Agent **David Shiang** married Helen Chan in June. She works for DEC; he works for Prime. The two of them are living in the house he grew up in in Winchester, Mass. David reports that fiscal 1987 was a VERY GOOD YEAR—48 percent of the class contributed to the Alumni Fund for a total of over $60,000. David continues to be the world's most avid Doors fanatic.

Class treasurer **Marty Davidoff** wrote, too. His two children, now 6 and 5, are doing fine. Last year Marty was a delegate to the White House Conference on Small Business. Marty would also like classmates to know that there is only $1,100 in the Class of 1974 Intramural Athletic Fund. This fund, in the past, has been used to build a softball field and re-hab the weight room at M.I.T., and, if you wish to continue to support intramural athletics, you must specifically designate your gift to the "Class of 1974 Intramural Athletic Fund."

Dick K. Yue has been promoted to associate professor of ocean engineering at M.I.T.

Charles T. Lederer passed away in May 1986, according to a note from his mother. Charles was involved in a one-car mishap near his home in Tucson, Ariz.

An article in early July in the *Boston Globe* has a spokes-person for the Massachusetts Water Resources Authority touting **Paul Levy** as the "white knight" they are looking for to spearhead that agency's effort to clean up Boston Harbor. Anyone who has been near the harbor at low tide knows what a monumental effort Paul is undertaking.

So maybe your own cleanup efforts only entail the basement. Write! Please note the new address.—**Lionel Goulet**, Secretary, 115 Albemarle Rd., Waltham, MA 02154-8133

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Arthur P. Rosiello writes that he has finally completed his residency training in neurosurgery at New York University and plans to spend another year there as a fellow while looking for a "real job, preferably in academics." . . . **James P. Demers** is living in Manhattan and working in New Jersey as a medicinal chemist for Ortho Pharmaceutical, where he's quite excited that a compound he developed is being considered for clinical testing. He's hoping it will one day be marketed. . . . **Glen C. Speckert** is still at Lawrence Livermore National Laboratory doing Vax Cluster and distributed microwave control systems for the Laser Isotope Separation Program. . . . Proving you can go home again, **Peter A. Schulz** has returned to our alma mater (Lincoln Labs, in particular) after 11 years away. He has a son now who turns 1 this fall. . . . **David R. Carino** reports that he at long last finished his dissertation and received a Ph.D. in engineering-economic systems from Stanford University in June. In September, after a summer of travel he began working for Frank Russell Co. in Tacoma, Wash., doing R&D investment manager performance evaluation. He still loves backpacking and is looking forward to doing lots of it in the Northwest.

Congratulations to **David A. Fink** on his marriage to Barbara Simko on May 9, 1987. According to the newsclip I received, David is a doctoral candidate in aeronautical engineering at—where else?—M.I.T. . . . **Michael S. Cucchissi** has joined the law firm of Pettis, Tester, Kruse & Krinsky as a founding partner. The firm represents major companies in southern California on corporate securities, business, real estate, and tax law matters. . . . After serving as general manager, marketing, **Robert S. Mann, Jr.** has assumed the position of vice-president, Market Information Systems, for Pan American World Airways, Inc.

David P. Weilmuenster has been elected as president of the M.I.T. Club of Northern California for the 1987-88 club year. . . . Through the Pawtucket, R.I., *Evening Times*, I've learned that musical classmate **Arna Zucker**, who sings and plays all sorts of instruments including trombone, piano, guitar, harmonica, tambourine, clevae, cabasa, rainmaker, and "no problem" (a type of washboard used in reggae music from the West Indies), has been performing (on a hobby basis only) with a group called The Units in Rhode Island.

Unfortunately, I must end this column on a sad note. I regret to inform you that classmate **Dwight D. Gibson** passed away on June 5, 1987. He is survived by his wife, Lisa.—**Jennifer Gordon**, Secretary, c/o Pennie & Edmonds, 1155 Avenue of The Americas, New York, NY 10036

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We have some news via the mails. But please do send more. **David Maass** was featured in the "Entreprenuers" column of the *Hartford* (Conn.) *Courant*. He founded a company, Advanced Composite Products, Inc., which is booming. He has developed a new composite, thermoplastic composites, and a manufacturing process.

Robert Struth writes, "Currently stationed at the Pacific Missile Test Center as an F-14 flight test officer. Will transfer soon as a navy employee to Grumman Aerospace Corp. at Calverton, Long Island, to be deputy officer-in-charge of the USN Super Tomcat (F-14D) flight test trainer." . . . **Everett Carter** is an oceanographer at the University of Rhode Island. . . . **Gregory Salzman** writes, "Now living in Ann Arbor, Mich., where I have a research appointment at the University of Michigan Institute of Labor and Industrial Relations. I also am an assistant professor of economics at Albion College. I have been married for eight years. My wife is a physician and has just finished her internship." . . . **Joseph Tavormina** writes, "In November 1986, I joined Electromagnetic Sciences, Inc., recently selected as one of the top ten defense electronic 'rising stars,' as manager, microwave marketing."

Stephen McConnel says, "Still working for Wycliffe Bible Translations as a computer programmer, finishing four years here. I'm also playing French horn in a local church ensemble, where they'll let almost anyone play." . . . **Larry Appleman** says, "Finally getting my M.I.T. degree (June 1). I entered with the class of '76; for a time I was registered as class of '78; and now I guess I'm '87. In August I'll be starting part-time at New England School of Law. Also, continuing as senior software engineer at Mirror Systems, Inc., in Cambridge." . . . **Alan Levin** writes, "Recently joined Softbridge Microsystems in Cambridge, as director of marketing. All is well at home. April (5.5) and Todd (2.5) are turning out to be good kids. It's amazing how fast the years go by though. Moved into a larger house a few months ago—just a mile away from our old one. Another .5 kid and a dog and we'll achieve 'average' family composite status."

Carl Shapiro has been promoted again, to full professor in the Department of Economics of the Woodrow Wilson School of Economics at Princeton. He has been teaching at Princeton since 1980. . . . **Richard Sobel**, M.D., has been appointed as an instructor at Jefferson Medical College of Thomas Jefferson University and is a member of the medical staff of Thomas Jefferson University Hospital. He has specialized in psychiatry. . . . **Carl Thompson** has been promoted to associate professor of materials science and engineering at the 'Tute. His research has centered upon grain growths in thin films, and he heads a large research program focused on microstructural evolution in thin films. . . . Also at the 'Tute **David Gifford** has been promoted to associate professor of electrical engineering and computer science. He got his Ph.D. at Stanford, and after one year as research scientist, he went back to

M.I.T. as an assistant professor, holding the ITT Career Development Chair from 1984-86 and the KDD Career Development Chair since.

I had the pleasure of a phone call with **Mike Sarfatti**. Mike has left Raychem, where he had risen as a manager, to join Merrill Lynch as a broker trainee. . . . **Jeffrey Hallis** has left investment banking at Merrill Lynch in favor of Coniston Partners. Your secretary would like to hear from other classmates on Wall Street. There may be enough of us to form a little club, if there is interest among people in New York.

As for your Secretary, this past summer has been a busy one. Stalco Futures, my brokerage firm, has been growing in its specialized institutional niche. We do not lack in volatility, which is the principal ingredient for obtaining futures hedging business, as well as providing speculative opportunities. However, the speed of some of the moves is giving me a few grey hairs! Like **Alan Levin**, I am amazed at how quickly the time has passed. My daughter is growing very rapidly. Where has the time fled? Please write; we need the news. There are still many classmates we have not heard from in many years.—**Arthur J. Carp**, Secretary, Stalco Futures, Inc., 225 W. 34th St., Suite 1705, New York, NY 10122, (212) 736-1960

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Hello, classmates, and welcome to a new era of appearances in *Tech Review*. The successful and enjoyable 10th reunion is now ancient history—those of you who did not attend missed a great time. Plan on joining us in five years! As you undoubtedly have heard by now, at the class meeting we elected officers for the next five years. After another close election, we find **Charlie Shooshan** returning for a second tenure as president; the vice-president is **Ira Goldstein**; **Ninamarie Maragioglio** (that's me) is the new secretary-treasurer; and the executive committee is made up of **Walter Goodwin**, **Kevin Miller**, **Dave Dobos**, and **Eric Black**. **Carol (Catalano) Martin** will continue to serve as class agent.

I will share with you the many tidbits of information I picked up at the reunion, as well as material recently sent in to the *Tech Review* office. Please bear with me if some of this information is stale or repeated from previous issues. I decided it's better to risk redundancy than to exclude any of your news.

Jonathan Herland is doing research in physiology at Brigham and Women's Hospital in Boston. He is the only one who managed to get two desserts at the class banquet at Long Hill Estate in Beverly. . . . **Charles Dietrich**'s informal but informative tour of the botanical gardens at Long Hill was worth half the price of the reunion dinner. Of course, the other half probably went for insect repellent. . . . Having two Risa Beth Goldsteins walking around the estate made for some mild confusion. One is married to **Ira Goldstein**; one is married to **Eliot Goldstein**. They're easy to tell apart though; Ira's wife is the one with the whistle that can stop traffic in the next state!

The alumnus who traveled the farthest to be at the reunion was **Leo Harten** of Cambridge (Mass., that is). Leo came in from East Germany where he was attending a conference on computer algebra. When he is in town, he maintains the DOE-MACSYMA for a living. . . . **Carlos Acevedo-Lucio** and his wife Eileen have moved back to the states after seven years in Puerto Rico with DEC. They leave behind many acres of land and a beautiful view in exchange for the crowded Boston suburbs. They will continue to work for DEC.

Paul Ackman ("still looking for a Jewish woman with catholic interests for a secular relationship") is living in Torrance, Calif., and enjoying his retirement. He travels a great deal and this year has toured in northern California, New Mexico, and Mexico. Paul planned to spend the summer in Guadalajara, Chiapas, in southern Mexico, and Guatemala. . . . **Richard Stone** has been in Middletown, N.J., for a year and a half now. He works at Bell Labs. . . . **Anthony Abner** is a resident in radiation oncology at the University of Louisville, where he received his M.D. in 1985. He claims that he chose an M.D. program over a Ph.D. one because he didn't have to write a thesis (exactly my reasoning for choosing my undergraduate majors!).

Michael Herrera lives near Baden, Switzerland, and is working as an instructor for Brown Boveri, the largest Swiss engineering firm. Michael is collecting master's degrees; he has one in engineering, one in French (from Middlebury College), and is currently working on his master's in German. Michael has become quite a polyglot and is looking for a fulfilling and lucrative way to combine his interests in languages and linguistics with his interests in engineering and science. He would be happy to hear from friends who are in Europe at Dorfstrasse 21, 5412 Gebenstorf, Switzerland, (41)56-233201. . . . **Debbie Darago** and Calvin Winey, '80, live in Tewksbury, Mass., with their two daughters, Larissa, 5 (my godchild), and Tatiana, 2 (**Mike Di Novi**'s godchild). Michael, who was unable to attend the reunion because of a southern California vacation, is a chemist at Monnell Chemical Senses Center. He and his wife, Beth Barnet, live in Philadelphia, where she is doing a residency in family practice medicine.

Christophe Berg and his wife, Christine, were expecting an October baby when we saw them at the reunion. They live in Holliston, Mass. . . . **Arlie Sterling** got his Ph.D. from the Sloan School. He and his wife, Josie, live in Cambridge with their son, Graham, who was born May 14, 1986. Arlie writes decision support software for MARSOFT, a software company in Cambridge, of which he is the president. . . . Another Massachusetts denizen is **Joe Forgione**. He and his wife, Maria, are the parents of a 4-year-old boy.

Steve Aaronson is also involved in software in his own consulting company. He came to the reunion from his home in southern California. . . . **Robert Lustig**, husband of Sharon Lowenheim, '79, is an M.D. working in research in pediatric endocrinology.

From the mail bags, we learn that **Jane Brown** is greatly enjoying her pediatrics practice in Needham, Mass. "However," she writes, "my greatest joy was the birth of a son, Benjamin Solomon Stone, on January 22, 1987." . . . **Joseph Mickey** is now a member of the technical staff at Loral Advanced Technology in Maryland, an electronic warfare equipment corporation. After a brief stint as a dancer with Ballet Theatre of Annapolis and a punk phase "with bleached hair and all," he has settled down to "normal Yuppie living." He has no 'Bimmer' yet (someone help—I need a translation!).

Stewart Landers reports that he is "happy, healthy, hardy, and whole" and living in Newburyport, Mass. He would like to extend thanks publicly to Marc ('Heart of Gold') Truant, '78, for use of his Saab after Stewart totalled his own Toyota. . . . **Robert Willmore** is a deputy assistant attorney general in the Civil Division of the U.S. Department of Justice. He heads the Tort Branch, which is responsible for defending the United States in all tort litigation. . . . **Ernest Davis** is teaching computer science at New York University. His wife, Bianca, is a student of medieval Jewish history. . . . **Patricia Clark** is happily married to John Bryson and enjoying life in Chapel Hill, N.C. After finishing medical school and an internship, she is pursuing a Ph.D. in epidemiology. We are saddened to hear that she recently had a daughter who died of complications due to prematurity.

Werner Haag writes, "After two-and-a-half years, I'm slowly getting used to living in California. My wife Franzi works at Stanford as an environmental microbiologist and I am in the throes of contract research at SRT International as an environmental chemist. We seldom get longer holidays, but have had the chance to do some classic climbs, like Whitney and Shasta. Have had the pleasure of keeping in touch with Karen and **Derek Morikawa**."

Victor O.K. Li has been promoted to associate professor, with tenure, of the Department of Electrical Engineering at University of Southern California. He also was elected chairperson of the Technical Committee on Computer Communications for the IEEE Communications Society for a two-year term beginning July 1987. . . . And speaking of election results, **Frank Fuller**, a former squash captain, is now the president of the Massachusetts Squash Raquets Association.

And now, if you are still awake, I will catch you up on the last ten years of my life in just six sentences. In 1979, I married **Paul Hertz**, while we both were graduate students. I spent four years at the Institute in a Ph.D. program in cognitive psychology; Paul got his Ph.D. in astronomy from Harvard in 1983. Our daughter, Joia, now 5, was born three days after I submitted my thesis proposal, and that is as far as my academic program went. In early 1983, we moved to the Washington, D.C., area; we bought a house in Springfield, Va., in the summer of 1985 and moved in just three weeks before our son, Kellen, now 2, was born. (As you can see, I seem to have a problem timing things just right.) Paul works as an astrophysicist at the Naval Research Lab in D.C., and I have settled into a fulfilling suburban life caring for our two wonderful children full time. Even though my days are far from empty, I really feel as if I have no excuse for not submitting this column regularly, religiously, and reliably—unless you do not let me know what you are up to! At the reunion, **Steve Blatt** indicated that he would like to see our class produce a column longer than that of another recent class (which shall remain nameless). So pick a class, get out your rulers and check it out. If this column doesn't do it, I'm eager to meet that challenge for next month. So unless you care to read all about my daughter's ballet class and my son's two-year molars, you must provide the stuff for this column yourselves. Old friends, new friends, soon-to-be friends—please write, and better still, if you live in or are passing through the D.C. area, feel free to get in touch with me at (703) 455-8459. I loved seeing you all at the reunion, and I look forward to renewing and making still more friendships in my new role as secretary. This column will continue to be as interesting and informative (and long!) as you make it. Remember to have patience; it takes at least four months for your submission to travel from your pen to these printed pages. C'mon all you out there—keep me busy!—**Ninamarie Maragioglio**, Secretary, 8459 Yellow Leaf Ct., Springfield, VA 22153

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Donna Carothers Tracht, wife of **Allen Tracht** recently sent me an announcement of their marriage on September 14, 1986. The Trachts live in Cleveland Heights, Ohio, where Allen works for, and is part owner of, an electronics company called IO Tech, manufacturer of IEEE U88 buses. After getting an M.S. in electrical engineering from Cal Tech in 1980, he came to Cleveland for the M.D./Ph.D. program at Case Western Reserve University. He took a leave of absence from the program to work for IO Tech, then made the leave permanent. Donna got her Ph.D. in Biochemistry from Case Western in May and at press time was looking for gainful employment.

Jordan Kreidberg graduated in May from the M.D./Ph.D. program in molecular biology at Johns Hopkins University in Baltimore. After eight years in Baltimore, he is looking forward to his return to Boston to do a residency in pediatrics at Children's Hospital.

Andrew Weiss has kept the moving men busy since his last appearance on these pages. First, General Electric moved him to Charlottesville, Virginia, to be manager of strategic planning for their factory automation division, then they moved him back to Connecticut to be strategic ac-

count manager on the corporate marketing and sales staff. Says Andrew, "This, apparently, is GE's way of showing affection!"

Tim Johnson was married last April 18, to Zenaida Sun De La Cruz of Toronto. Since October of '86, he has been a senior development engineer for Allen-Bradley AQS Division, which sells automated fastening systems for factory automation. . . . **Warren Manning** finished his first year of cardiology training at Beth Israel Hospital in Boston. He and his wife Sue were expecting their second child in September (so, what was it?!)

Robert Briselli writes, "I'm just in the middle of moving to another house, about a mile from my last one—still in the 'Motor City'. Hope all you Honda Accord drivers out there are happy; you're driving the best made car with the best paint—mine. I was in Toronto recently for a bridge tournament and bumped into Mike Lipkin. By the way, what's happening with all those 'dial-a-fourths' from NH-2? I'm always looking for a marathon bridge game, remember!" . . . **Scott Macfarlan**, as you may recall from an earlier column, is vice president-director of branches for NCNB National Bank of North Carolina in Charlotte. He spends his free time organizing new Boy Scout troops in Charlotte, sailing, and skiing.

That's all for this month. Hope to hear from more of you next time.—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

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Greetings once again from Cambridge and Happy Holidays! Lots of mail in the sack this month, so on with the show. . . . **Scott Norton** writes that he's currently a lieutenant in the U.S. Navy studying for an electrical engineer's degree at the Naval Postgraduate School in Monterey. In his free time, he's been bicycling extensively along the Pacific Coast and in the mountains. At the time he wrote, he was planning to ride in the 100-mile (!) "John Steinbeck" Century. . . . **Marion Nodine** entered Brown University in September to begin work on a Ph.D. in computer science. . . . We received a press release notifying us that **Jeffrey Berman** has been elected vice-president of Justin PC Architects in New York. Jeff joined the firm in 1980 and has served most recently as project manager for the firm's work on projects for the Port Authority of New York and New Jersey and in hospitals and health-related facilities.

Brent Dixon writes that he and Patti added a new family member July 9, 1986, with the birth of John Patrick. His brother Robby can't wait until John gets old enough to play with. . . . After spending five years as a consulting engineer in San Francisco, **David Damery** has given up California life to get an M.B.A. at Carnegie Mellon University in "sunny" Pittsburgh. . . . **Richard Kocinski**, meanwhile, is enjoying life in New Jersey despite working excessively (he says) to bring a space station contract to RCA/GE. He says, "I love my new bike; training on it may allow me to achieve my marathon obsession."

Bob Silverman is a flight instructor at NAS Whiting Field where he occasionally runs into more-recent M.I.T. alumns who are going through the program. He's married and has two children. He expects to be looking for a new job shortly, preferably in flight testing. . . . **Arthur Chin** is keeping busy in Cherry Hill, N.J., with wife Bee and son Jeremy, born March 2 of this year. Arthur has been with Mobil R&D since getting his M.S. in chemical engineering from Berkeley in 1982.

Lieutenant **John L. Stenard** married Amy Gillett, sister of classmate **Ed Gillett**, a couple of years ago and has one child and another on the way. Though still in the navy, John returned to M.I.T. for a master's degree last year and joined the wrestling team! He managed to take fourth place at the New Englands at heavyweight. His brother-in-law, Ed, is an M.D. and on his recent residency in England met a "cute Welsh lass" who also rows.

An article from *Tech Talk* (remember that?) informs me that Dupont assistant professor of Ceramics, **Yet-Ming Chiang** (of M.I.T.'s Department of Materials Science), has been elected to serve a two-year term in the Mitsui Career Development Professorship. Yet-Ming received his Sc.D. from M.I.T. in 1985; he had been appointed Dupont assistant professor in 1984. . . . **R. Scott Wilson** received his Ph.D. in chemical engineering from the University of Wisconsin in 1986 and is currently working as a Surface Scientist for LOF Glass, Inc., in Toledo, Ohio.

Also in academia is **John N. Tsitsiklis**, who was recently promoted to associate professor in M.I.T.'s Department of Electrical Engineering and Computer Science. John had joined the M.I.T. teaching staff in September 1984 and became an assistant professor in November. His main interest is in distributed systems, but he also does research in control theory, operations research, communications theory, and theoretical computer science.

Ed Chang writes that he just received his M.S. in operations research from University of California, Berkeley and will be returning to the North Bay Secondary School in Orinda, Calif., to teach high school math. (He has taught there before.) He is also a shareholder (and former vice-chairman) of Enlightenment, Inc., a venture-capital-backed educational software company. The company's first product teaches people how to play chess.

Finally, rumor has it that **Mary Rorabaugh** is making the big move from a finance position (manufacturing controller) at VLSI Technologies, Inc. to a position in their operations area.

That's all for this month folks. Thanks to every one who wrote! And have a great New Year!—**Kate Mulroney**, Secretary, 256 Hampshire St., No. 3, Cambridge, MA 02139

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Hello again everybody! The mail campaign is off to an excellent start. Again this month, I have received many letters and postcards from our classmates. However, there are still many of you who have not written once in the six and one-half years since graduation. Life cannot be so boring that you have nothing to say. . . or so exciting that you cannot find five minutes to write! I am eagerly awaiting more letters.

Lorenzo Sadun decided to "check in sometime before 1993." He's been playing musical coasts. He started graduate school in physics in 1981 in Berkeley and then somehow followed his advisor back to Harvard where he graduated in May 1987. Now he's heading west again to pursue a postdoc at Caltech in the math department. Lorenzo reports that moving east to attend Harvard did have some redeeming qualities.—he's currently engaged to Anita Glazer (Harvard, '84). . . . **Peter Jernakoff** earned his Ph.D. in chemistry from Harvard in 1986. Following that, he did a year of postdoctoral work at Penn State. Now, he is employed by the Dupont hydrocarbons research group. Peter is engaged to Katheryn Warren, '85. They are planning a spring 1989 wedding after she graduates from University of Connecticut Medical School. Peter also has news of two of our classmates. . . . **Kevin Bowie** is working as a production manager at Technical Materials, Inc. in Lincoln, R.I. . . . **Thomas Semple** got his Ph.D. in chemistry from Brown in December 1986 and is currently in a postdoc program at Yale.

Wayne Webster received his master's degree in metallurgy at M.I.T. in 1982 and for the past five years has been working as a development engineer at Reynolds Metals in Richmond, Va. Wayne was married to Donna Jo Kostyk of Richmond in July 1987. Congratulations. . . . **Ellen Fischer** wrote to say that she is doing well and living in Brooklyn, N.Y. She recently started work at the College for Human Services and is enjoying working in SoHo. She took up skiing last winter and is looking forward to lots of snow in 1988. . . . **Steven Meltzer** graduated from Harvard Business School in 1986 and is living in Boston where he works as an investment manager for Scudder, Stevens, and Clark specializing in insurance company portfolios. . . . **John Wenn** reports that he's hard at work on his Ph.D. in computer science at Carnegie Mellon University in Pittsburgh. John says hello to fellow Student House alums.

Bill Ogilvie is living in Vancouver, B.C., where he is working for Gemini Technology. He reports that M.I.T. alumni are quite rare up there, however he has become friendly with Suk Lee, '83, and his wife, Emi Hasegawa, '84. Bill also has the opportunity to visit Japan this spring, where he especially enjoyed Ryoangi and the Zen rock garden. . . . **Amy Luttinger** completed her first year of graduate school in molecular biology at Princeton. She claims to still have Kandy the cat and the usual rats, frogs, and things. . . . **Cliff Heyer** is living in Weston, Mass., and is enjoying much success with his computer hardware/software consulting business. . . . **Watts Humphrey** is living in Belmont, Mass., where he is in the building business with Turner Construction. Watts seems to be enjoying himself and says that visitors are welcome.

William Watkins is entering the final year of his residency in emergency medicine at the Martin Luther King Hospital in Los Angeles. . . . **William Scott** has been named vice-president of the Information Networks Division of Contel ASC, formerly American Satellite Company. . . . From the *Princeton Weekly Bulletin*: **Steven Karel** has joined the Chemical Engineering Department after receiving his Ph.D. from Stanford in 1986.

I saw **Manny Oliveria** in July at a party of some mutual friends. He is doing well and working hard to complete his Ph.D. in materials science and engineering at M.I.T. . . . I saw **Paul Marcus** in downtown Boston the other day. He is a partner in a real estate construction firm in the Boston area. . . . I am trying to enjoy the final weeks of Boston summer weather while trying to manage a hectic work and travel schedule. Take care and keep the letters coming. Next column in 1988.—**Lynn Radlauer**, Secretary, 216 Beacon St., Boston, MA 02116

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The holidays are upon us as you read this but our fifth year reunion is recent history as I write it. The reunion was lots of fun, although the dinner at the Boston Tea Party Ship unexpectedly turned into a Greek dinner in Cambridge due to a last minute hitch. The entire weekend was handled with aplomb by our newly-elected class prez, **Mark Walker**, now a lawyer at Hughes, Hubbard and Reed in NYC.

News from the reunion: **Glenn Ackerman** left his job as a consultant at American Management Systems in Arlington, Va., took some time to travel around the Carolinas and started a Ph.D. program in economics at the University of Chicago in the Fall. . . . **Eve Ahlers** and **Bill Nunan** are now married and working on Ph.D.s in electrical engineering at UCLA. . . . **Lloyd Bloom** loves New York City and his job as an actuary for Metropolitan Life Insurance. . . . **Arno Bommer** has been working since graduation as an engineer for an acoustical consulting firm in Houston. . . . **Patricia Robinson Boucher** married M.I.T. grad student Charlie Boucher; they are the proud parents of Colleen and work for Harris in Palm Bay, Fla. . . . **Cedric Detmar** worked for Megatest in Milpitas, Calif., before starting at UCLA Business School in the Fall. . . . **Ellen Drascher** works for InteliCorp in Sunnyvale, Calif. . . . **Erin Hester** recently moved back to Boston to work for the city's public facilities department. . . . **Lina Janivicius** has worked as a diffusion engineer for SMC in Long Island since graduation.

More from the reunion: **Angie Liao** still finds time for musical theatre and was recently in the cast of the first community theatre production of "A Chorus Line". . . . **Lucinda Linde** graduated from Harvard Business School (that's why she's our new class treasurer!) and works for Ceramics Processing Systems in Cambridge. . . . **Allen Oppenheimer** works at Apple in Cupertino, Calif., where he met his wife Priscilla. . . . **Victor Quintana** and **Donna Woo** are married and the proud parents of Laura Woo, the femme fatale of the fifth year reunion. Victor works in R&D for Polaroid in Cambridge. . . . **Elena Rozier** is out of the Marine Corps and works for Xicor in Milpitas, Calif. . . . **Galen Seitz** is now in Portland, Ore., working at Tektronix. . . . **Dave Surber** is working for British Petroleum in San Francisco. . . . **Mitch Tasman** is working on a master's degree in computer science at the University of Wisconsin at Madison. . . . **Kim Vermeer** spent two years in Africa with the Peace Corps and recently finished a master's degree at Harvard's Kennedy School of Government.

In the midst of the reunion there was also a Concourse reunion, with appearances by **John Hainsworth**, **John Woods**, **Kevin Osborn**, **Jonathan ("JC") Cohen**, **Cheryl Wheeler**, and **Rick Cohen**, among others. Since then Rick, who is still working as a software engineer at DEC, has married **Mindy Garber**, who is working in customer support for BBN-Advanced Computers in Cambridge.

Our West Coast correspondent also attended an M.I.T. Club of Northern California picnic held in July, along with **Rich Novo** (now at Signetics) and his wife **Robin Brown** (who works at California Biotech). They reported on the following Burtonites: **Rosanna Sun** is working in technical training at Rolm. . . . **Dave King** is finishing his Ph.D. at Stanford and is married to Agnes Wong '83, a medical student at University of California, Davis. . . . **Joanna Fischler Myers** married Cory Myers '79, and works at Mitre. . . . **Sue Taliaferro Juncosa** married Ed Juncosa '83, they live in Billerica, where she teaches high school. . . . **Steve Sloan** is in the M.D./Ph.D. program at New York University. . . . **Bruce Levy** married Amanda Gruber '85 and they are both medical students in New York City. . . . **Kathy Hsu** is getting married and works for Hewlett-Packard in the Silicon Valley.

And then there are the non-reunion tidbits: **Rich Blumenfeld** is working as an electrical engineer for United Technologies in Norwalk, Conn. . . . **John Hollis**, now happily married, graduated from veterinary school in Tuskegee, Ala. . . . **Stephanie Wingfield** received her master's in architecture from M.I.T. . . . **Kathy Anderson Lee** is working steadily on her Ph.D. in chemistry in Raleight, N.C., her husband, **Jeffrey Lee**, should have gotten his Ph.D. by the time this is in print. . . . **Eric Leiser** is a photoresist applications engineer for E.M. Chemicals (Merck) in Darmstadt, Germany; the lucky devil gets to travel all over Europe and the Far East. . . . **Allison Casey** has been working for Motorola in Phoenix since graduation; she recently found the time to take a week-long river rafting trip through the Grand Canyon. . . . **Jeffrey Sakaguchi** has left Chevron to pursue an MBA at Wharton, after having played on a Volvo Tennis Team (doubles) that qualified for the nationals in Las Vegas in 1986.

At the reunion, your classmates wisely decided to elect three secretaries to ensure that the flow of classnotes never ceases again. So who are your trusty class secretaries? The West Coast correspondent is **Michelle Gabriel**, now working as a product engineer at Aventek in Newark, Calif., after working for Motorola in Phoenix for two years; she can be reached at 656 S. Fair Oaks Ave., D-211, Sunnyvale, CA 44086. . . . Her East Coast counterpart is **Linda Schaffir**, who finally received her Master of Architecture degree from the University of Pennsylvania last December and is now working as a designer at SMS Architects in New Canaan, Conn., learning to play the guitar and performing with a local musical theatre group; she can be reached at 18 Prospect Ave., Apt. B-2, Norwalk, CT 06850.

I guess I get the middle of the country, which is fine since I am spending a lot of time these days in Chicago seeing my geographically undesirable significant other, **Ken Snow**, who is in the second year of a residency in internal medicine at Northwestern. In between, I'm a lawyer at a nonprofit environmental group in Boston.—**Stephanie Pollack**, 33 Trowbridge St., Cambridge, MA 02138

83 5th Reunion

Hello and Happy Holidays to all members of the class of '83. In a few short months, we will be together again at our first class reunion. By now everyone should have received a letter about the reunion and class dues. If any of you have not received reunion information, the event will be taking place at M.I.T. Thursday, June 2, through Sunday, June 5, 1988. Mark your calendars. Judging from the past, the Alumni Office expects about 150 of us to show up, but I think our numbers will be close to 100 percent. Spread the word.

Our class members have been up to some pretty amazing things since the last issue, but that doesn't surprise me. We hear that **Thomas Wolfe** has received his M.B.A. from the University of Virginia, Darden School of Business. He is expected to be heading to Luke, Md., to work for Westvaco Corp. . . . **Thomas Greene** has been promoted to CAD/CAM department manager at Prime Computer. . . . **Steven Marshall** is now senior engineer for storage systems at DEC.

Jeffrey Lipton, as we all know, is a Lipton tea lover. However, since he graduated from Jefferson Medical College in Philadelphia, he has been very lonely. He is currently attending Duke University and would love to hear from anyone from M.I.T. He is at 4-B Post Oak Rd. in Durham, NC 27705. . . . **John Pittrelli** has decided to finish his Ph.D. by 1989. He is determined to finish all remaining degrees before he reaches his third decade of existence. . . . **Henry Gonzalez** has migrated to the Special Welfare Division of the Naval Coastal Systems Center working as a project engineer of manned submersible and ROV projects. . . . **Michael Lopez** has continued to excel in everything he does. He is now working for Teknor Apex in Pawtucket, R.I., as sales coordinator in the Rubber Mixing Division.

Of course, every column has a celebrity '83. This issue it goes to **Michael Keane** because of his very prestigious fellowship. Mike's thesis, "An Analysis of the Federal Reserve System's Nonborrowed Reserves Operating Procedure," was good enough to receive an $11,000 stipend plus tuition for one academic year. Mike plans to continue in economics at Brown University.

As for myself, things continue to be fun in New York City. I am really looking forward to seeing everyone at the reunion. Keep the letters coming.—**John E. De Rubeis**, Secretary, 14 Charles Ave., Port Washington, NY 11050

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Merry Christmas Class of '84ers!

Seng-Tiong Ho has received a renewed award from the Newport Corp. and the Optical Society of America for his research on the generation of squeezed-state light. He is currently a student at M.I.T., Course VI, pursuing a Ph.D. . . . **Charles Marge** graduated from M.I.T. in June of '86 with two Masters, one from Sloan, and the other from the Operations Research Center. He is currently living in Somerville with Gary Girzon and working for Arthur D. Little, Inc. He's a consultant in the Logistics Unit of the Operations Management Section, and loves it. He's still active in the M.I.T. music scene, primarily as assistant conductor and bass clarinetist of the M.I.T. concert band.

James ("Bomber") Bishop, Jr., married **Celia Chao-chin Hsu** on May 17, 1987, and is living in Richardson, Tex. **Judy Chow** was married on August 15, 1987, to Henry Lee. . . . **Jim Ellard** traveled to Scandinavia last June, along with Diane Hess '85. . . . **Sue Marinow** is working in Boston for BBN, along with **Julie Tiao**, '83. . . . **Robert Lezec** is living in Boston.

Philip Gleckman, formerly of APO and Senior House, was married to Jeonsook Kim of Chicago, in Chicago on July 31, 1987. **Darryl Palmer** was the best man. . . . **John Rice** is working as a Materials Engineer for Dow Chemical in their Corporate Ceramics Research Lab. He was married to Deborah Meinholz, '85, in July 1987, in Plymouth. . . . **Don Gillies** is now a graduate student in Computer Science at the University of Illinois, in his hometown of Urbana. He spent six weeks last summer at NASA's research center at Langley, in Virginia. . . . **Andy Levy** is married and has twins, with another on the way!. . . . **Jenny Shandling** is married to another Burton 3rd Bomber, but I don't know who!

Remy Malan, '83, writes with some '84 news. . . . **Ahsan** and **Linda Iqbal** are living in St. Louis where Linda is at Medical School at St. Louis University, and Ahsan is planning to start graduate school at Washington University. . . . **Sim Park** is working for TRW in Redondo Beach, Calif. Remy's wife Hitomi is studying at the Oregon Graduate Center, and they live in Aloha, Ore.

I received a letter from **Steve Korthals-Altes** the other day. (That is his real name, by the way.) He and his wife Barbara are living in the D.C. area. He works for the office of technology assessment of Congress on a study of advanced space transportation technologies. Barbara got her Master's from Harvard's Kennedy School of Government last June, and was chosen as a Presidential management intern. She is working for the Treasury Department in their policy planning office.

There was a mini Pi Lam reunion in Hermosa Beach, Calif. last June. In attendance were: **Dan Battista** (the host), **Mike Cation**, **Tim Kneele**, **Bob Abramson**, **Phil Nelson**, Mike Maguire, '86, Mark Brine, '85, Dave O'Donnel, '85, Rob Webster, '87, Jeremy Rochelle, '85, John Lang, '85, Rick Flores, '86, Bob Schaeffer, '82, Todd Hylton, '83, and myself. It was quite the event, featuring the annual Hermosa Beach Pub-Crawl.

Vivian Wang spent last summer in Los Angeles working for a small architectural firm in Santa Monica called Morphosis. . . . **Rob Pokelwaldt** is studying business in Spain. . . . **Larry Coury** was in L.A. last summer visiting **Sim Park** and **Mark DeCew**. I saw them at a club near my house where Andy Summers (former guitar player of the Police) was playing. . . . Paul Kegelmeyer, '85, is in L.A. also, working for Hughes Aircraft. . . . As for me, I started a new job last July. I'm still at TRW, but no longer in engineering. I'm now a business person, working as a subcontract administrator. So far I like it. I hope to be starting my M.B.A. soon. I went to see David Bowie with **Vivian Wang**, and he was GREAT! So was Andy Summers, for that matter! . . . Keep the news flowing—**Diane M. Peterson**, President, 350 Palos Verdes Blvd., Apt. 20, Redondo Beach, CA 90277-6329, (213) 375-4991

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Seasons Greetings! **Curtis Tsai** updates us on the brothers of Theta Delta Chi: "Quite a few of us continued past the bachelor's degree, and most stopped after getting their master's degrees at M.I.T. As of September, **Jim Rydock**, **Brent Foy**, and I were the only ones left in graduate school at M.I.T. Jim is in the Meteorology Department after taking some time off in Europe and California. Brent is studying for a Ph.D. in the HST program and married Sue Pratt (Lesley, '84) last July. I finished my master's degree in EECS and am continuing for my Ph.D. **Mark Brown** and **Joe Parrish** completed their master's degrees in Aero/Astro at the end of the summer. Mark is working for JPL in Pasadena, Calif., and he is engaged to Lisa Melchior (Wellesley, '85). Joe is in Washing-

Morris Tanenbaum (above right), chairman of the National Action Council for Minorities in Engineering (NACME) congratulates Lance Parker, '84, system project engineer for NEC America, Inc., Melville, N.Y. Parker was among four engineers to receive NCME's 1987 Alumni Award for his activities in the minority engineering effort. Looking on are John Hill (rear left), a fellow awardee from Reprographics Business Group, and Peter Likins, president, Lehigh University.

ton, D.C., working for Booz-Allen. **Tom Esselman**, **Lary Ward**, **Alan Foonberg**, and **Dan Lane** finished their master's degrees and found life better in California. Tom received his degrees in EECS in June 1987 and is working for ADS in Mountain View. Lary finished in Aero/Astro last February and has been working for Integrated Systems; he also lives in Mountain View. Alan lives in Hermosa Beach and works for The Aerospace Corp. Dan works for TRW and lives in Venice Beach. Finally, **Loginn Kapitan** and **Chris Warack** are both working for the air force. Loginn has purchased a home in Yucaipa, and Chris (married to Karen Smith, Mount Holyoke, '85) bought a condo in Rancho Palos Verdes."

I received another great letter from **David Fung**. He writes, "Since graduating from M.I.T., I've graduated from Columbia University (May 1987) with an M.S. in chemical engineering. I will begin working as an engineer with Air Products and Chemicals, Inc. in late August. Early last July, a few brothers of PSK's class of '85 organized a get-together at Hilton Head, S.C. We all stayed at **Lee Rowman**'s beautiful summer house. Lee is still working for Chemical Bank (New York City) as a data processor in the management training program. He's been there since graduation with fellow M.I.T.er **Diane (Muffy) Hess**. Robert Walsh drove to South Carolina from Jackson, Miss., to be with us. He's working for Mobile Oil Corp. as a sales engineer. Work is keeping him busy although he seems to find time to complain about living in the "deep" south! **Mark Panarusky** flew in from Lawton, Okla., where he is working for Goodyear Tire and Rubber Co. He recently relocated there from the company's headquarters in Akron, Ohio. **Paul Walsh** drove from the Boston area, where he works for New England Biolabs in Beverly. Donald drove from Champaign-Urbana, Ill., where he's attending grad school (University of Illinois) in computer science. He probably wouldn't have come to Hilton Head except for the fact that he got a summer job with NASA in Hampton, Va.! **Steve Bauer** used the occasion for a summer vacation. He is working for Hewlett-Packard in San Diego. We had a great time and look forward to doing something like this again!"

While **Bob Sugar** was in town, he stopped by. He is working for Information Storage Inc. in Colorado Springs. Before that, he was a "free agent" working for Unisys. . . . **Libby Patterson** and **Tom Rucker** were married on July 22. Tom is just wrapping up his Ph.D. in chemistry at Berkeley. . . . **Pamela Mitchell** is attending Stanford Business School. Happy Holidays all!—**Stephanie Scheidler**, Secretary, 1026 Live Oak Dr., Santa Clara, CA 95051, (408) 985-6827

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Salutations. The letters did pick up a bit this month. Thanks to all of you who write in—you make my job a lot easier. Second lieutenant **Jim Wilkerson** wrote in from Arizona, where he is attending undergraduate pilot training for the air force. He says the flying is awesome and the night life is pretty good (Arizona State is quite close). Jim stopped at Wright-Patterson Air Force Base, Ohio, on his way to Arizona and saw second lieutenant **Jim Hilbing**. He's working with the Foreign Technology Division and seems to be very happy. Jim also found out that **Rich Maurer** is in pilot training at Reese AFB, Tex. Jim wraps up by saying that Scott Tennent, '89, and Keith Colmers, '89, went through Williams AFB for their field training T-37 rides.

Gwen Smith and **Jim Sturdy** were married in August of last year and both are still at M.I.T. Jim hopes to graduate in December and leave the nest. . . . **Carolyn Beer** sent me a postcard from Las Vegas. She was visiting with two friends from school and got to see Sammy Davis, Jr. and Jerry Lewis. The best thing, though she says, is that drinks are free in the casinos. . . . Second lieutenants **Pam Sullivan** and **Andrew Peddie** graduated from undergraduate space training at Lowry Air Force Base in Colorado. They will assume duties associated with the space operations career field. . . . **Karen Lee** was selected by the Tau Beta Pi's Fellowship Board for a graduate fellowship.

Two more living groups wrote in. **Scott Lawton** reported in on German House. He, **Lars Bespolka**, **Chris Raanes**, and Hillary Thompson, '87, flew out to San Francisco in June. They met up with Max Hailperin, '85, Stefanie (Helferich) Hailperin, '84, Melanie Mauldin, '85 and Phil Sohn, '88. They did a little water skiing, sailing, jet skiing, sculling, etc. before returning to the East Coast with Astrid Kral, '89. Lars is an investment banker for First Boston in New York City. Chris was a 6-A co-op with RCA, finished his master's in electrical engineering last June and now works for Adaptive Optics in Cambridge. Scott is currently a mechanical design engineer for the Perkin-Elmer Corp. Instrument Group in Norwalk, Conn. Scott, it seems, is restless about both career and social life and drives up to Boston at least once a month. . . . **Donna Giesman** is a grad student at University of Pennsylvania in genetics. She leads a Catholic folk group on campus and recently splurged for a new piano. **Tom Kurfess** also got his master's in electrical engineering in June. . . . He is staying at Draper Lab to pursue his Ph.D. and recently became engaged to Adriana Praddaude, '87. . . . **Greg Zancewicz** took a year off at Motorola in Illinois. He's now married and back at M.I.T. in the electrical engineering graduate program.

Joe Lo writes in about all the ATO grads. Joe graduated in June from Stanford with a master's in mechanical engineering. He is currently employed in Atlanta, Ga., for AT&T Bell Labs. He says his job is really awesome! . . . Bill Mayweather is starting work in San Diego for Qualcomm after finishing his master's in electrical engineering from M.I.T. . . . **Dave Lyons** is in Europe this summer and will be working for Dupont in Detroit when he returns. . . . **Rajiv Bahl** and **Greg Zehner** are working for Goldman Sachs in New York. . . . **Brett Miwa** is pursuing an electrical engineering master's at M.I.T. while **Bill Gentry** is doing the same in economics at Princeton. . . . **Greg Frazier** is at University of California Los Angeles working towards a master's in computer science.

Second Lieutenant **Jim Nugent** was out here to visit last week. He was interviewing at Space Division (Los Angeles, Calif.) to see what type of jobs were available. He seemed pretty impressed.

That about wraps it up. Until next month.—**Mary E. Cox**, Secretary, SD/CLTPC P.O. Box 92960, Los Angeles AFS, Los Angeles, CA 90009-2960

COURSE NEWS

I CIVIL ENGINEERING

M.I.T. civil engineers continue their near-monopoly of honorary memberships in the Boston Society of Civil Engineers with the selection of three new honorees late last spring: **Harl P. Aldrich, Jr.,** '47, founding partner in Haley and Aldrich, Inc., Cambridge; **Paul S. Crandall,** '42, founder of Crandall Dry Dock Engineers, Inc., Boston; and **Donald R.F. Harleman,** Sc.D.'50, Ford Professor of Engineering at M.I.T. Before the election, living honorary members of BSCE included only **Albert G.H. Dietz,** '32, professor emeritus of building engineering at M.I.T. and John A. Volpe, retired founder of Volpe Construction Co., Boston. Aldrich is cited by BSCE for his professional leadership, Crandall for his guidance to young civil engineers through 40 years of practice, and Harleman for research contributions in the areas of fluid transport and mixing.

To **James C. Howland,** S.M.'39, engineering consultant in Corvallis, Ore., honorary membership in the American Society of Civil Engineers. Howland, who was the founding partner of the engineering firm of CH2M in 1946, was cited for "contributions to the profession in management and excellence in engineering."

Robert J. Thrasher, S.M.'65, of Stamford, Conn., has been named general manager of customer services for New York Telephone's Long Island area, responsible for overseeing provision of communications services to the company's Nassau and Suffolk County customers.

Three deaths have been reported to the Alumni Association, with no further details available: **Axel O. Bergholm,** '32, of Chatham, N.J., in 1986; **Shelby H. Curlee,** CE'60, of Creve Coeur, Mo., on January 29, 1987; and **Holger P. Mittet,** S.M.'38, of Edmonds, Wash., on June 30, 1987.

II MECHANICAL ENGINEERING

Michael A. Feldstein, S.M.'66, joined North Atlantic Industries, Inc., as division vice-president and general manager of the Data Storage Products Division, Hopkinton, Mass. Feldstein was formerly vice-president—engineering at Shugart Associates, Sunnyvale, Calif. . . . **Robert H. Wolin,** S.M.'37, a retired consultant of Chatham, Mass., was an unsuccessful candidate for a seat on the Chatham (Mass.) Board of Selectmen last May. Before starting his own consultant firm in fossil fuels, R.H. Wolin Associates, Inc., Wolin served (for 38 years) as vice-president in charge of fossil operations at Combustion Engineering, Inc., in Hartford, Connecticut. Wolin, a 10-year resident of Chatham, has served as a member of the Chatham Natural Resources Advisory Committee and chairman of the Chatham Solid Waste Advisory Committee.

Major General **Robert G. Butler,** S.M.'34, U.S. Army (retired), known for pioneering work in atomic energy, passed away in Bridgeport, Conn., on February 21, 1987. Butler's military career began with graduation from West Point in 1928; in 1942 he was assigned to the Manhattan Project in Washington, and after World War II he was an original member of the Atomic Energy Commission, serving as deputy director of military applications. In 1954 Butler became a one-star (brigadier) general, receiving his second star (major general) the following year. He retired in 1959 as commanding general of the Ordnance Special Weapons Command, Picatiny Arsenal, New Jersey. Following retirement, Butler moved to Osterville, Mass., and taught for several years at the Hopefield Broadview School, Sandwich, Mass.

David R. Pryde, S.M.'32, of Hendersonville, N.C., passed away on May 19, 1987. Pryde worked for 30 years at the General Electric Co. as a mechanical engineer. He was also affiliated with the Public Service Commission of New York State for seven years. Involved in community affairs, Pryde was an elder of the Covenant Presbyterian Church, Hendersonville, a 32nd Degree Mason, and chaplain of the Hendersonville Shrine Club.

III MATERIALS SCIENCE AND ENGINEERING

Professor **Thomas W. Eagar,** '72, of M.I.T. will be a major speaker at AIME's 1987 Mineral Economics Symposium on November 19 in Washington. His topic at the luncheon: "Cooperative Research and Technology Transfer in Japan."

What to do with sewage sludge? Simple, says **Samuel R. Maloof,** S.M.'45, writing in the *Boston Globe*. Despite new policies that limit sludge disposal in the ocean, properly treated sludge can provide "a valuable source of nutrition to marine plant and animal life," writes Maloof, a consultant to High Voltage Engineering Corp. Maloof's proposed treatment is disinfection by high-voltage electrons—a process in which High-Voltage Engineering has a major interest.

To emphasize the critical importance of high-technology ceramics in industrial development, the American Ceramic Society has assembled a score of essays edited by **W. David Kingery,** '48, Kyocera Professor of Ceramics at M.I.T., into a volume of *High-Technology Ceramics—Past, Present, and Future: The Nature of Innovation and Change in Ceramic Technology*. Among contributors, in addition to Kingery, are six members of the M.I.T. community: Professor **Morris Berg,** Sc.D.'53, of the University of Illinois; Professor **Linn W. Hobbs** of M.I.T.; Professor **Heather Lechtman** of M.I.T.; **Elaine Rothman,** S.M.'82, of Harvard Business School; Professor **Merritt R. Smith** of M.I.T.; and Professor **Eric A. von Hippel,** S.M.'68, of M.I.T.

Lisa C. Klein, Ph.D.'77, has been promoted to professor of ceramics at Rutgers University, Piscataway, N.J. In 1986 Klein was honored with the Karl Schwartzwalder-PACE Award from the American Ceramic Society for achievements to the profession by a young ceramic engineer.

W. Michael Yim, Sc.D.'61, of Princeton, N.J., passed away on June 27, 1997; no further details are available.

V CHEMISTRY

Professor **Satoru Masamune** of M.I.T. was honored late last spring by election to the American Academy of Arts and Sciences.

Hilliam R. Moser, Ph.D.'64, a member of the chemical engineering faculty (since 1981) at Worcester Polytechnic Institute, has been granted tenure. Moser's area of specialty is chemical catalysis, particularly metal catalysis. Following graduation from M.I.T., Moser spent 17 years working in private industry in the United States and Europe before joining WPI. His assignments included senior research chemist for the Exxon Corporate Laboratory and director of the Catalytic Research Laboratory the Badger Co., Cambridge.

Donald M. Black, Ph.D.'47, reports from New Canaan, Conn., that he reached retirement age last April, and was elected to continue working as regulatory compliance manager for Van Waters and Rogers, Inc. He and **Elizabeth Sackmann Black,** S.M.'47, have four children, two daughters and two sons. Their son, Donald T., '71, holds a law degree from the University of Pennsylvania and is now senior patent counsel for the Revlon Group, New York City; and their second son, Thomas P., '80, M.B.A. from Dartmouth, is now with Arthur Anderson & Co., Boston.

John Twiss Blake, Ph.D.'24, a 44-year veteran at the Simplex Wire and Cable Co., Cambridge, passed away on June 26, 1987. Blake joined Simplex as a specialist in the chemistry of rubber and other dielectrics. Over the years he advanced to retire in 1966 as division senior vice-president, secretary, treasurer, director and member of the executive committee. Blake's affiliations included: fellow of the American Institute of Chemists, the American Association for the Advancement of Science, and the Institute of Rubber Industry (England); as a member of the American Chemical Society he was chairman of its Northeastern Section from 1957 to 1966, and he received the Goodyear Gold Medal (1953) for research on rubber.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Three members of the department community were honored last summer with the rank of fellow in the Optical Society of America: Professor **Steven R.J. Brueck,** Ph.D.'71, of the University of New Mexico for contributions to "the spin-flip Raman laser and to stimulated surface polariton scattering"; Professor **Hermann A. Haus** of M.I.T. for "quantum electronics, particularly contributions related to semiconductor lasers"; and Professor **Cardinal Warde** of M.I.T. for work on "the Lummer-Gehicke interferometer, on the spatial light modulator, and on adaptive optical systems."

Thomas H. Lee, Philip Sporn Professor of Energy Processing, Emeritus, has returned to Cambridge following his three-year term as director of the International Institute for Applied Systems Analysis at Laxenburg, near Vienna. Lee's great-

est accomplishment at IIASA, he says, was to put the organization on a solid financial footing following the withdrawal of a substantial fraction of American support; it remains a vital center for east-west collaboration on such critical world problems as energy, population, agriculture, and natural resources.

Professors **Joel Moses** and **Albert R. Meyer** of M.I.T. were honored late last spring by election to the American Academy of Arts and Sciences.

Can a new approach to software engineering close the nation's "software gap"? asks the promotional literature for a new Software Productivity Consortium of which **Howard L. Yudkin,** Ph.D.'65, is president. Fourteen companies are pooling resources and manpower to underwrite the consortium with headquarters in Reston, Va.; the plan is to develop new software and strategies for the use of computers in designing software—automatic software development methodology, in the language of the prospectus. "The results of our work will make a radical difference to software quality and productivity," says Yudkin.

VI-A Internship Program

The Petroleum Club in Dallas was again the site for the annual Texas Instrument Luncheon hosted by **Cecil H. Green,** '23, on August 6, 1987. Some 45 executives, managers, and VI-A students attended, including your correspondent. Dallas had the distinction of hitting 106° that day.

At the luncheon we also had the honor of celebrating Cecil's birthday, his 87th, by presenting to him a card signed by a number of those attending. I had the opportunity to tell the gathering about the change in VI-A directorship and a little about my projected new duties. **Joseph D. Zimmerman,** '59, vice-president of TI, brought greetings from TI's current management. His son, Dale '81 was also at the luncheon. Dale did his VI-A work at TI and is now employed by the company. Cecil's friendly and informal role as master-of-ceremonies made us all feel a part of the TI VI-A family.

At the conclusion of the luncheon **Dean R. Collins,** '58, volunteered some very complimentary remarks on John Tucker's interaction with students, giving an example of his own while a student. He also was grateful for John's assistance to TI during his tenure as VI-A Director and expressed everyone's thanks to John.

Two other VI-A alums, now employed by TI, who attended the luncheon were **Christopher Slawinski,** '83, and **Albert Taddiken,** '85. In addition **Jeffrey D. Beck,** '71, was there as manager of one of the present students. Jeff did his VI-A work at Honeywell Electro-Optics Division.

JoAnn and George Berryman were, again, my delightful hosts, inviting me to stay at their home during my visit and taking care of my arrival and departure from DFW airport.

VI-A seniors applying for the graduate phase of the Program were notified by Registration Day of the graduate office's initial decision of admissibility. A total of 81 percent of the seniors had applied, and 78 percent of these were granted "S.M.-only" admission; the remaining 22 percent were put on "hold" pending another review at the end of the fall term.

The August issue of *The Institute* reported the death of **John N. Pierce,** '54. Mr. Pierce, a Fellow of the IEEE, was principal scientist at Signatron, Inc., Lexington, Mass., and in his professional life made major contributions in the fields of radio communications, algebraic coding and underwater communications. His cooperative work was done at the Air Force Cambridge Research Laboratory, which he joined as a civilian scientist upon graduation from M.I.T.

Bruce D. Wedlock, '56, has been elected chairman of the board of the IEEE's Electro 1988. Bruce is Director of the Lowell Institute School at M.I.T. and is a Fellow of the IEEE.

An announcement of the Boston IEEE Instrumentation Measurement Chapter lists a program on "Superconductive Signal-Processing Devices"

to be chaired by **Richard S. Withers,** '75, who did his VI-A thesis work at the Naval Surface Weapons Center. He is currently an associate group leader at M.I.T.'s Lincoln Laboratory.

Mark Annis and family visited the VI-A office while up from Gillette, N.J. . . . **John V. Burroughs,** '82, tells us he is now with Data General in Westborough. He and his wife have two children. . . . **Michael R. Crystal,** '86, called to say he is living in Watertown, Mass., and working for BB&N.

One August afternoon we had a visit from **Barry Goldman,** '76, and his wife who were in the area from a vacation on Cape Cod. Barry is now with Goldman Sachs & Co. in New York (no relation) and lives in Ft. Lee, N.J. They were planning a get-together later that evening at Boston's Quincy Market with **Frank T. Chang,** '77, and **Leon K. Woo,** '77, with whom they've kept in contact.

A surprise visitor to the VI-A Office in September was **Louis A. Nagode,** '80, east from Colorado to attend a friend's wedding. He and I had a great chat and enjoyed lunch together. Louis is now with Northwest Instrument in Colorado Springs. . . . **Ashok Popat,** '86, visited the office in early August. He's with Hewlett-Packard Co. in California.

I also had a telephone conversation with longtime friend **Melvin M. Weiner,** '55. Mel and I were involved with Eta Kappa Nu's Boston Alumni Chapter when I first joined M.I.T. in 1956. Mel is with MITRE Corp. in Bedford, Mass., and has published a book. His oldest son graduated from Brandeis this past June and plans graduate work at Brown University.—John A. Tucker, Special Assistant to the Department Head for VI-A & Lecturer, Room 38-473, M.I.T., Cambridge, MA 02139.

X CHEMICAL ENGINEERING

Harris J. Bixler, Sc.D.'60, has been elected chairman of the Bigelow Laboratory of Ocean Sciences (Bar Harbor, Me.) board of governors. Bixler began his professional career as a member of the department at M.I.T. and in 1964 moved to industry. In 1983 he joined Delta Chemicals, Inc, Searsport, Me., as vice-president and general manager. Early this year he formed Brown's Head Ventures, an investment and consulting firm. . . . **C. Judson King,** Sc.D.'60, formerly dean of the College of Chemistry, has been named provost of the professional schools and colleges at the University of California, Berkeley. King, a 24-year faculty veteran at Berkeley, formerly served as vice-chairman (1967-72) and chairman (1972-81) of the Department of Chemical Engineering. His research is in electrical separation processes, including food dehydration and concentration, and he holds the William H. Walker Award of the AIChE and the Westinghouse Award of the American Society for Engineering Education. . . . **John G. Polk,** S.M.'54, formerly president for packaging operations at Primerica Corp., is senior vice-president of Triangle Industries, Inc., New York City.

XI URBAN STUDIES AND PLANNING

Philip B. Herr, M.C.P.'59, of Philip B. Herr Associates, Boston, has been chosen by Hanover, N.H., to be a principal planner and consultant for the proposed new Dartmouth-Hitchcock Medical Center. Herr and his associates will study the physical and social impacts of this new project.

James R. Richardson, M.C.P.'81, was in Beijing, China, last summer leading an urban design studio at Qinqhua University. Participants included 13 students from China and 20 students from North American universities. Richardson taught with **John de Monchaux,** dean of the School of Architecture, and **Dennis Frenchman,** M.C.P.'76, director of the Environmental Design Group both at M.I.T. Richardson is currently

Renaissance Skills Turn Planner to Publisher

For nearly 20 years after he graduated from M.I.T., Alan Wofsy, M.C.P.'67, carved out a career in real estate development and building rehabilitation in San Francisco that is an entirely predictable exploitation of his M.I.T.-acquired expertise. But in 1987 a new opportunity knocked, and Wofsy suddenly found himself publishing the *San Francisco Review of Books (SFRB).*

SFRB was founded in 1975. A decade later, under the able editorship of founder Ronald E. Nowicki, it had emerged as a literary magazine of considerable reputation. It was ready for the infusion of enthusiasm and resources that Alan Wofsy provided when he assumed the roles of publisher, art expert, and banker in April 1987.

Wofsy and editor Nowicki insist that, unlike most literary periodicals, the *SFRB* has no political slant. They acknowledge only their literary bias: no science fiction, mysteries, or romance novels will be reviewed. They agree that their magazine addresses the same audience that reads the *Times Literary Supplement* and *The New York Review of Books.*

Wofsy's influence at the magazine was first felt in its August issue–a new format, new features, new distribution. The four-color cover, reproducing a classic Japanese illustration, testifies to Wofsy's devotion to graphic and illustrative arts. So do the issue's interior graphics: What other small (5,000 circulation) literary magazine boasts interior interviews, reviews, and cultural pieces set off by so many woodcut reproductions, drawings, and illustrations? A Dickensian-like Grandville print graces the cover of the early fall issue.

The August issue also brought nationwide distribution for the magazine. Boston-area alumni, for example, found copies at B. Dalton Bookseller and Waldenbooks. Major features in August included "AIDS and Censorship," a look at how information on this killer disease is still being withheld from the public. Local novelist Barry Gifford had a profile of the Village Voice bookstore in Paris. Of particular interest to Bay Area readers was a critique of *San Francisco Chronicle* architecture critic Allan Temko. Charles Pappas contributed an irreverent piece on American journalists in El Salvador, "Dead Men's Socks." Among the many new departments were: "The Arts and The Law," by Chris Goodrich and "A Letter from New York," a behind-the-scenes look at publishing in Manhattan; "Foreign Correspondent," a re-visit to Berlin on its 750th anniversary; and a tour of local art galleries.

Wofsy encourages M.I.T. graduates to submit pieces for a section of the magazine that will be called "State of the Art," featuring articles written for the layman about cutting-edge technology.

Wofsy doesn't consider his publishing venture a long way from his career in city planning and development. "Building buildings, cities, books–all are much the same," he says. Every issue of the magazine, every building is a discrete creation. "Each time you start over."

Wofsy's interest in *SFRB* also reflects his diversity. Publishing art reference books and bibliographies has been a career second only to real estate. Among Wofsy's rehab projects in the Bay Area are the transformation of a defunct military base to large-scale woodworking space, a drycleaners turned recording studio, several low- and moderate-income housing projects, and a renovated hotel that now houses *SFRB.*—*Nancy R. Spears* □

The August 1987 issue of the* San Francisco Review of Books *reflects the influence of its new publisher Alan Wofsy, M.C.P.'67. At the helm since April, Wofsy's devotion to graphic and illustrative arts brought about changes in format, new features, and new distribution. This issue was the first to be marketed nationwide since the magazine's founding in 1975.

(1987/88 academic year) visiting assistant professor of architecture and planning at M.I.T., on leave from his academic post in the School of Architecture and Planning at the University of New Mexico.

P. W. Wood

XIII OCEAN ENGINEERING

Mark Jay Moeller, Ph.D.'82, has been named assistant professor of mechanical engineering at the University of Lowell, Mass. A specialist in flow-induced vibration, Moeller was formerly an engineering specialist at Electric Boat. . . . **William Donald Needham,** Oc.E.'86, reports that he is serving as repair officer on the *USS Hunley* (AS-31), which (last June) returned from Holy Loch, Scotland to Norfolk, Va., after a five-and-one-half-year deployment overseas. Needham was advanced to commander on May 1, 1987.

Antonio Edmundo L.M. De Rezende, Ph.D.'78, is project manager at Copfetic (Federal University of Rio De Janeiro), responsible for the area of transportation information systems development. . . . **Peter W. Wood,** N.E.'55, has joined the Defense Group of ERC International, Fairfax, Va., as senior vice-president. Prior to this appointment Wood served for 20 years at Booz, Allen & Hamilton, most recently as senior vice-president. At ERCI, Wood plays a major role in the Defense Group's defense, space, and information systems consulting operations. . . . **Peter B. Bowman,** Oc.E.'73, Captain, U.S.N., took over command of the Portsmouth (N.H.) Naval Shipyard last May. Bowman's most recent previous assignment was as planning officer at Mare Island Naval Shipyard, Vallejo, Calif. He has served on the *USS Picking, USS George C. Marshall, USS Patrick Henry* and *USS Canopus*.

E. Roger Kirk, S.M.'40, of Toledo, Ohio, passed away in December 1986; no further details are available.

XV MANAGEMENT

Tsuneo Sakai of Fuji Photo Film Corp., Tokyo, entered the Sloan master's program unexpectedly this fall in the glare of newspaper headlines. He'd originally enrolled in the Simon School of Business at the University of Rochester. But many Kodak employees are students there, and Eastman Kodak Co. objected: Sakai might inadvertently be told some important company secrets. The complaint set in motion a call from the Rochester dean, **Paul W. McAvoy,** once a member of the Sloan faculty, to his former colleague Dean **Lester Thurow**—and eventually to Sakai's acceptance at M.I.T.

How Japan modernized itself in the image of the West is the subject of *Imitation and Innovation: The Transfer of Western Organizational Patterns to Meiji Japan* by Professor **D. Eleanor Westney** (1987: Harvard University Press, $25.00). The changes between 1868 and 1912 rank among "the most remarkable social transformations in modern history," she says. The book is described as "a signal contribution to the literature of the transfer of social technologies across cultures."

Paul W. O'Gara, S.M.'68, is the inventor and promoter of INFO Baseball, which is described as a bridge-like card game based on baseball statistics. In an interview with the *Berkshire Eagle*, O'Gara credits the concept to his father, for 36 years sports editor of the *Eagle*: "Dad came up with the idea of using baseball statistics on playing cards," O'Gara told the *Eagle*'s Alan Cooperman. "What I have done is make the game more playable, with simple rules and several levels of difficulty, so that it can be played by either a 10-year-old or an adult." What O'Gara has also done is produce a first edition of 10,000, marketed during the summer throughout New England. O'Gara is spending half-time on the project, the other half in his consulting business on market research.

Scholars "have great theories and even considerable knowledge"; activists "have great rallies and are very effective at passing laws or electing candidates." But scholar/activists are different: "We believe that just doing something isn't always better than doing nothing, and that is important to analyze the impacts of changes and choose the most important course of action." That definition from Alice Rivlin, former director of the Congressional Budget Office, was inspired by the career of Professor Emeritus **Phyllis A. Wallace,** and it is part of Rivlin's remarks at a two-day conference honoring Wallace held at Endicott House last summer.

To complete his organization of the Sloan School, Dean **Lester C. Thurow** named two deputy deans late last summer: Professor **Arnoldo C. Hax** is responsible for teaching programs and Professor **Glen L. Urban** for research activities. And **Donna M. Behmer,** former assistant dean, has been named associate dean for finance and administration.

Sloan Fellows

Boston Magazine reported in a midsummer issue on **Richard Santagati,** S.M.'79, in his new career as chief executive officer of the Boston law firm of Gaston Snow and Ely. A nonlawyer, Santagati was previously president and chairman of NYNEX Business Information Systems Co., New York. Says *Boston*, "Santagati applies with almost disturbing accuracy the skills he learned at M.I.T.'s Sloan School . . . while on a fellowship awarded him after 10 years in the ranks of New England Telephone. . . . He recognizes the status of an M.I.T. management degree and wears proudly the school's gold ring embossed with a mighty beaver. The degree propelled him into a power position at NYNEX, which in turn catapulted him to his plush perch at Gaston Snow."

Frank J. Bellafato, S.M.'75, formerly manager of the General Motors assembly plant in Framingham, Mass., has recently transferred to a special assignment with GM's Cadillac-Pontiac-Canada Group (which includes the Framingham plant), Warren, Mich. . . . **Richard Michael Ross,** S.M.'81, reports, "As president of International Paper Realty Corp. of South Carolina (from January 1985 to April 1987), I directed the development of the Haig Point golf course, club, and residential community on Danfuskie Island, S.C. Currently I am director of all marketing for International Paper's Container Division out of Memphis, Tenn." . . . **Alma Thomas Young,** '72, corporate vice-president at Martin Maritta since 1985, has been promoted to senior vice-president of the corporation and president of Martin Marietta Electronics and Missiles Group, headquartered in Orlando, Fla.

William L. Clark, '40, of Big Bend, Calif., passed away on June 29, 1986. Following six years of active duty in the Army Air Corps during World War II as a colonel and gunnery expert, Clark joined U.S. Steel, Pittsburg, Calif., as an industrial engineer. Later he became director of engineering at the Del Monte Corp., San Francisco. Clark leaves his wife Twila, two daughters, one son, two step-sons, and 15 grandchildren. . . . **George O. Knapp,** '37, of Darien, Conn., formerly associated with Union Carbide Corp., passed away on May 7, 1987; no further details are available.

Management of Technology Program

Gerry Ferrentino, S.M.'87, called to say that last July 6 he accepted a position as systems analyst for the Equity Arbitrage Group of Shearson-Lehman Brothers in New York. Gerry is responsible for providing technical support to those doing trading in microcomputer technologies for mainframe to software. . . . **Amanda Gillum,** S.M '87, spoke with Program Director, Mario Gnecco, last July 22. She reported that she accepted an offer from Eastman Pharmaceutical in Pennsylvania. This is a new division of Eastman Kodak that will be entering the pharmaceutical field. Amanda anticipated a lot of traveling with this job, as the initial developments of Eastman Pharmaceuticals are being farmed out. She will be in charge of development activities in the area of anti-viral and anti-cancer drugs as well as the screening of natural products for possible pharmaceutical applications.

Koichi Kodama, S.M.'84, visited the Program Office last June while in Cambridge on business concerning a small venture company located in this area. He was winding things up in New York, as he will be transferred to Japan for the next two or three years. Koichi said that his wife, Miyuki, is very happy to be going home. . . . A letter from **John Krawiec,** S.M.'85, reported that as of last June he was taking a new position at Morton Thiokol in the Composite Technology Projects Office at the Marshall Space Flight Center, Huntsville, Ala. He will be working with NASA in the Productivity Enhancement Facility doing R&D work. John and his wife, Roz, are very happy about this move and are looking forward to building a new home in the Huntsville area.

Jim Timmons, S.M.'87, is really enjoying his new job as manager of biotechnology commercialization at the Amoco Corp. On a recent business trip to the Boston area, Jim stopped by the Program Office to meet with Mario Gnecco. . . . **Eric Schmidt,** S.M.'87, visited the Program Office last June 26. Eric has started work as strategic planner for Varian Associates, Palo Alto, Calif. Since his wife, Lorraine, was staying in the Cambridge area until last September, Eric made frequent coast-to-coast trips. . . . **Sorab Vatcha,** S.M.'85, stopped by last June 9. Sorab reported that he is building up his consulting business and has stopped teaching in order to devote more time to consulting.—Jennifer Mapes, Program Coordinator, Management of Technology Program, Room E52-125, M.I.T., Cambridge, MA 02139

XVI AERONAUTICS AND ASTRONAUTICS

Speaking for himself and his former crewmates Neil Armstrong and Michael Collins, **Buzz Aldrin,** Sc.D.'63, told a professional meeting in Boulder, Colo., late last summer that marked the 18th anniversary of the first moon landing, "I hope it will be seen as significant by you that three very different and diverse men who crewed the first human flight to land on the moon are all in agreement on this: we endorse a declaration for Mars. . . . We'll get to Mars," Aldrin promised, "and we'll go beyond."

Robert C. Seamans, Jr., Sc.D.'51, senior lecturer in the department at M.I.T., headed a joint committee of the National Academies of Science and Engineering reviewing NASA plans for a space station, and Professor **Laurence R. Young,** '57, director of the department's Man Vehicle Laboratory, was a member of the committee. The task, jointly assigned by NASA and the White House, was to analzye long-term space station requirements and assess the cost of, and possible alternatives to, current proposals.

Oktay Yesil, S.M.'70, reports that he continues to work at the Boeing Commercial Airplane Co., Seattle, as a senior specialist engineer and leader of the Noise Technology Group. He was recipient of the 1987 Service Award presented by the AIAA Pacific Northwest Section.

Eugene R. Wells, Jr., S.M.'61, of Sacramento, Calif., passed away on November 1, 1985; no further details are available.

XVII POLITICAL SCIENCE

The U.S. Marine Corps has "been quietly winning the bureaucratic battles, encasing its outdated mission in concrete and establishing itself as our fourth armed service," wrote Professor **Harvey M. Sapolsky** of M.I.T. in the *Wall Street Journal* late last spring. As a result, "we have more Marines than we need," he said. Sapolsky argued that the main mission of the Marines—amphibious assaults—is so hazardous as to be unthinkable in modern warfare. With this principal mission in doubt, the Marines should make the same budget and manpower reductions that will be demanded of the Army, Navy, and Air Force in the next decade, said Sapolsky. "The Corps needs to adjust to the realities of modern warfare," he wrote.

Peter D. Lebling, S.M.'78, says M.I.T.'s tunnels and basements were the inspiration for *The Lurking Horror,* a new interactive fiction release from Infocom. It's Lebling's eighth release, his first horror story. The earlier titles are *Spellbreaker, Suspect, Starcross, Zork I, II,* and *III,* and *Enchanter;* Lebling is co-author of the last four, the first of which—*Zork I*—was a pioneer of the genre.

Norman Fainstein, Ph.D.'66, has been appointed dean of the School of Liberal Arts and

Sciences and professor of sociology and anthropology at Baruch College, City University of New York. Prior to this appointment, Fainstein taught for 11 years at the New York School for Social Research, New York City, where he was professor of urban affairs. Since 1985 he has been a member of the Higher Education Advisory Committee and (since 1977) has served as the American editor of *Ethnic and Racial Studies*, published at the University of London. Fainstein is also co-author with his wife, Susan, of *Restructuring the City: The Political Economy of Urban Redevelopment*, an urban development and planning study of the city of New Haven, Conn.

XVIII MATHEMATICS

Among 40 leading women mathematicians whose biographies are in *Women of Mathematics* edited by Louise S. Grinstein and Paul J. Campbell (Greenwood Press, 1987): **Cathleen Synge Morawetz,** S.M.'46. Morawetz became director of New York University's Courant Institute of the Mathematical Sciences in 1984, making her "the first woman in the U.S. to head a mathematics institute," writes biographer James D. Patterson. Morawetz earned her Ph.D. at NYU in 1951 and—except for one year at M.I.T.—has been there ever since, becoming professor in 1965 and head of the Mathematics Department in 1981 to 1984. Her work has been in applications of partial differential equations, especially shock waves and wave scattering.

Michael A. Arbid, Ph.D.'63, is co-editor with Allen R. Hanson of *Vision, Brain, and Cooperative Computation* (M.I.T. Press—Bradford, 1987), a survey of current developments in vision research. Arbid is professor of computer science, neurobiology, and physiology at the University of Southern California.

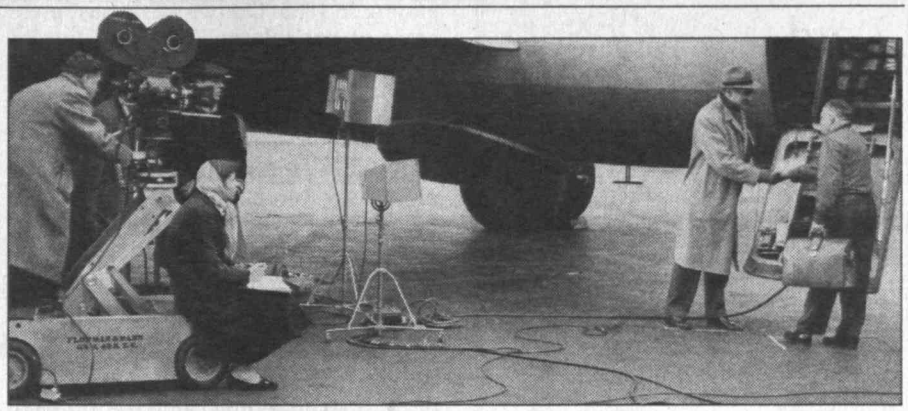
XXI HUMANITIES

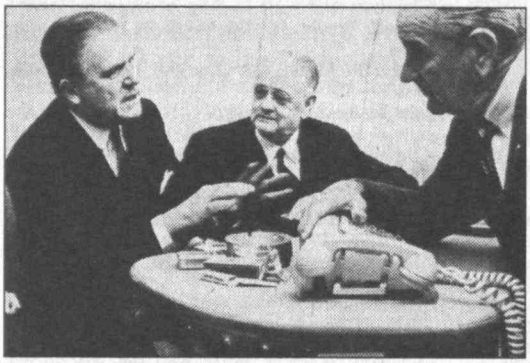
Loren R. Graham, professor of the history of science at M.I.T. who specializes in the relationship of Marxist philosophy to Soviet scientific progress, is the author of *Science, Philosophy, and Human Behavior in the Soviet Union* (Columbia University Press, 1987). It's a revised and expanded version of Graham's earlier (1972) book, *Science and Philosophy in the Soviet Union;* the new work is described by the publisher as "essential for historians and philosophers of science, and intriguing reading for anyone interested in Soviet scholarship."

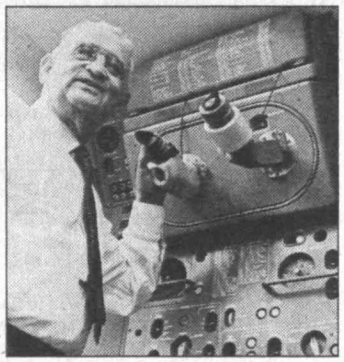
To **John Harbison,** Class of 1949 Professor of Music at M.I.T., membership in the American Academy of Arts and Sciences, granted at the Academy's elections late last spring. . . . And **Mark Harvey,** lecturer in music, was a member last summer of a National Endowment for the Humanities seminar at Harvard on "Approaches to the Study of Avant-Gardes"; Harvey is a specialist on jazz and modernism, the author of an essay on the aesthetics of Charles Ives published in *Connecticut Review* late last summer.

TECHNOLOGY AND POLICY PROGRAM

Dwayne Breger, S.M.'83, will begin a Ph.D. program in mechanical engineering at the University of Massachusetts, Amherst, while working with the Massachusetts Energy Office and the United States Department of Energy. . . . **Scott Pace,** S.M.'82, has entered the Ph.D. program at Rand Graduate Institute in Santa Monica, Calif. . . . **Robin Wagner,** S.M.'85, has left her assignment as assistant in the M.I.T. Dean's Office to start a Ph.D. program in occupational and environmental epidemiology at Johns Hopkins School of Hygiene and Public Health.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139







Highlights of the contributions of Charles Stark Draper, '26, to aircraft and spacecraft navigation and flight control (clockwise from top left): using a model gyroscope to demonstrate the principles of inertial guidance, 1957; departing with CBS newsman Eric Sevareid on a fully automated transcontinental flight, 1958; with NASA administrator James Webb and President Lyndon B. Johnson on Air Force One, 1964; and with a model of the Apollo guidance equipment, 1966.

Charles Stark Draper, 1901-1987: Genius of Aeronautical Innovation

Charles Stark Draper, '26, Institute Professor Emeritus in the Department of Aeronautics and Astronautics whom President Paul E. Gray,'54, describes as "one of the great engineering geniuses of the 20th century," died on July 25 following a short illness. At 85, he had been in declining health for several years, but he continued public appearances and occasional visits to the laboratory that bears his name until a few weeks before his death.

As the "father of inertial guidance," Draper had a profound role in the development of modern armaments, aviation, and spaceflight. And as a senior statesman of aeronautics and astronautics, he also was a major figure in aviation policy and designing the nation's space program.

The developments for which Draper is most famous began during World War II, when he conceived of exploiting the stability of a gyroscope to create navigation, guidance, and control instruments, gunsights, and fire control systems of unprecedented accuracy. Continuing this work after the war, Draper quickly became known as "Mr. Gyro" for the success of his fast-growing M.I.T. Instrumentation Laboratory in bringing inertial navigation to operational use in aircraft, submarines, missiles, and space vehicles.

Such monumental achievements as the Apollo landing on the moon and the guidance systems for all strategic missiles in the U.S. inventory, both land- and sea-based, bear the stamp of Draper's genius. So do the navigation systems on most of the world's commercial aircraft and spacecraft.

The interdisciplinary interests that characterized Draper's major accomplishments were evident in his youth, when Draper earned degrees in three fields—psychology (B.A. Stanford, 1922), electrochemical engineering (S.B. M.I.T. 1926), and physics (S.M. and Sc.D., M.I.T., 1928 and 1938). He joined the faculty in aeronautical engineering in 1929 and shortly thereafter drew a nucleus of colleagues and students into what became the department's Instrumentation Laboratory, from which came the stunning developments of World War II and the post-war decades.

Meanwhile, Draper rose to the rank of full professor, became head of the department in 1951, and was honored with the title of Institute Professor in 1966.

Seven years after that his Instrumentation Laboratory, a center for military research that was then seen as inappropriate to the educational environment, was divested from M.I.T. It took Draper's name and became a not-for-profit research center in Cambridge, and Draper took the title of chief scientist.

"Draper's work over a period of nearly six decades was marked by an indomitable will to succeed and an uncompromising demand for engineering excellence," wrote President Gray. He described Draper's contribution as "of enormous magnitude, ranging from early aircraft to the vehicles of today that move with precision on the sea, under the sea, through the air, and in space.

"Equally important," wrote Gray, "Draper was one of the country's great teachers. The hundreds of students he taught and inspired are now among the world's leaders in aviation and space exploration.

"His life was rich, rewarding, and inspiring, and his memory will live long."

Academician Alexander Y. Ishlinsky, leading Soviet gyroscope expert, wrote Draper on the latter's 60th birthday, "I respect you as one of the most remarkable engineers and scientists of our time." Vice Admiral Red Raborn, former director of the Central Intelligence Agency, credits Draper with "the most significant contribution to our country's defense in modern times."

Draper's countless awards included major prizes for engineering achievement—the Smithsonian's Langley Medal, the NASA Public Service Award, the National Medal of Science, the Goddard Trophy of the National Space Club, and the "Engineering for Gold" Award of the National Society of Professional Engineers, which listed inertial guidance as one of the ten outstanding engineering achievements of the 50 years

PHOTOS: M.I.T. MUSEUM

ending in 1985. Draper was a past president of the International Academy of Astronautics and an honorary fellow of the American Institute of the Aeronautical Sciences, British Institution of Mechanical Engineers, Instrument Society of America, British Interplanetary Society, Royal Aeronautical Society, British Institute of Navigation, and German Society for Guidance and Navigation.

A member of the National Inventors Hall of Fame, Draper had been chairman of the National Inventors Council and was the New England Inventor of the Year in 1981. Among more than 70 honors and awards, five came from foreign countries.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Mary Plummer Rice, '15; June 24, 1987; Petaluma, Calif.
Herbert C. Dimlich, '17; July 9, 1987; Pawtucket, R.I.
Arthur C. Kenison, '19; April 19, 1987; Northville, Mich.
James M. Strang, '19; July 1987; Pittsburgh, Penn.
Robert L. Burchell, '20; 1986; St. Petersburg, Fla.
William J. Dean, '20; July 18, 1985; Amherst, N.H.
John W. Rockefeller, Jr., '20; March 31, 1987; Asbury Park, N.J.
Henry A. Alter, '21; 1986; Waterbury, Conn.
Henry R. Kurth, '21; August 9, 1987; Falmouth, Maine.
Morris F. Sheldon, '21; May 21, 1987; Carmel, Calif.
Reginald H. Smithwick, '21; February 27, 1987; Jupiter, Fla.
Lawson T. Blood, '22; September 1, 1986; Arlington, Va.
Edwin H. Schmitz, '23; November 20, 1984; Norwalk, Conn.
Robert S. Stuart, '23; October 3, 1986; Philadelphia, Penn.
Elliott B. Davidson, '24; December 31, 1982; Calimesa, Calif.
Boynton J. Fletcher, '24; July 8, 1987; Vero Beach, Fla.
Edward A. Taylor, '24; February 24, 1986; Pocono Lake Preserve, Penn.
Eugenia Dritsas, '25; June 21, 1987; Branford, Conn.
John P. Sawyer, '25; March 10, 1987; Dorset, Vt.
Charles S. Draper, '26; July 25, 1987; Newton, Mass.
Arthur E. Keay, '26; August 4, 1987; Plymouth, Mass.
Horace R. Dyson, '27; May 14, 1987.
Harold Heins, '27; July 24, 1987; Marblehead, Mass.
Russell P. Westerhoff, '27; July 12, 1987; Ridgewood, N.J.
Richard Roth, '28; June 9, 1987; Purchase, N.Y.
Arthur R. Smith, Jr., '28; February 21, 1987; Toledo, Ohio.
Mrs. Edward S. Thompson, '28; 1987; Newport Beach, Calif.
Oliver L. Barker, '29; 1986; Falmouth, Maine.
Kenneth G. Garside, '29; May 25, 1987; Blue Hill, Maine.
Romeo H. Guest, '29; August 4, 1987; West End, N.C.
John Ade Plugge, '29; July 6, 1987; Chevy Chase, Md.
James E. Keely, '30; July 18, 1987; Silver Spring, Md.
Martin J. Feeney, '31; March 8, 1987; West Roxbury, Mass.
Leon F. Osinski, '31; October 24, 1986; Briarwood, Del.
Axel O. Bergholm, '32; 1986; Chatham, N.J.
Philip L. Brockington, '32; June 5, 1986; Delray Beach, Fla.
Libero F. Cappabianca, '32; July 10, 1987; Haverhill, Mass.
David D. Kiley, '32; July 12, 1987; Shrewsbury, Mass.
Kenneth A.H. Smith, '33; January 27, 1987; St. Petersburg, Fla.
George R. Vila, '33; July 8, 1987; Sharon, Conn.
Roland D. Eaton, '34; March 13, 1987; Chatham, Mass.
John Phillips, '34; June 1979; Jacksonville, Fla.
Edward Gelus, '35; March 28, 1987; Berkeley, Calif.
David E. Hollidge, '35; March 6, 1987; Milton, Mass.
Vincent J. Mooney, '35; May 1987; Floral Park, N.Y.
William E. Peterson, '35; June 30, 1987; Austin, Tex.
William O. Thompson, '35; June 3, 1987; Evergreen, Col.
R(alph) Marshall Christensen, '36; February 14, 1987; Greenwich, Conn.
Gardner A. Murray, '36; June 24, 1987; Woodbury, Conn.
Louis J. Proulx, Jr., '36; March 24, 1987; Rowley, Mass.
Holger P. Mittet, '38; June 30, 1987; Edmonds, Wash.
John A. Sawyer, '38; April 1, 1987; Forsyth, Ga.
John F. Snuggs, '38; April 22, 1986; Flossmoor, Ill.
Clinton W. Tylee, Jr., '38; March 28, 1987; St. Albans, Vt.
Elliott C. Fisher, '39; March 4, 1987; Naples, Fla.
Benjamin T. Howes, '39; May 28, 1987; Bloomfield, Conn.
Massimo Baer, '40; February 28, 1987; Longmeadow, Mass.
William L. Clark, '40; June 29, 1986; Big Bend, Calif.
Walter H. Farrell, '40; July 18, 1987; South Orleans, Mass.
Donald A. Howard, '42; April 20, 1986; Westwood, Mass.
Adam J. Miller II, '41; September 15, 1986; Glenview, Ill.
Richard W. Tindal, '41; July 1, 1987; Canastota, N.Y.
John M. Wheeler, '41; August 5, 1987; Greeley, Col.
Alfred Copeland, '42; March 28, 1987; Irvington, N.Y.
N(orman) Bruce Oakley, '42; July 16, 1987; Elkton, Md.
Arthur Fuerman, '44; June 29, 1986; Pottstown, Penn.
Clinton W. Murchison, Jr., '44; March 30, 1987; Dallas, Tex.
Wilbur F. Young, '45; July 18, 1987; Longmeadow, Mass.
Alan B. Draper, '47; March 23, 1987; Julian, Penn.
Robert H. Bliss, '48; August 26, 1987; George Mills, N.H.
Gabrielle Eva Donnay, '48; April 4, 1987; St. Hilaire, Canada.
Lloyd W. Hartman, Jr., '48; 1984; Indianapolis, Ind.
Leonard E. Meyer, '49; July 19, 1987; Washington, D.C.
Harrison N. Thibault, '49; March 13, 1987; Cornish, N.H.
Daniel E. Magnus, '51; April 17, 1987; Lloyd Harbor, N.Y.
Carl W. Steeg, Jr., '52; June 23, 1987; Fort Wayne, Ind.
David P. Landon, '57; March 14, 1983; Bensenville, Ill.
Donald R. Batten, '58; 1985; Rockville, Md.
Philip E. Beach, Jr., '59; July 23, 1987.
Robert F. Webber, '59; July 20, 1986; Longwood, Fla.
Shelby H. Curlee, '60; January 29, 1987; Creve Coeur, Mo.
Eugene R. Wells, Jr., '61; November 1, 1985; Sacramento, Calif.
W. Michael Yim, '61; June 27, 1987; Princeton, N.J.
Raymond G. Dowsett, '65; July 13, 1987; New Britain, Conn.
Peter DeMarques Wolfe, '66; April 13, 1986; San Francisco, Calif.
Naomi E. Kies, '70; 1987.
Jean M. Baranowski-Marks, '82; October 23, 1986; Ossining, N.Y.
Steven P. Kohler, '84; July 19, 1987; Derry, N.H.

ALLAN J. GOTTLIEB, '67

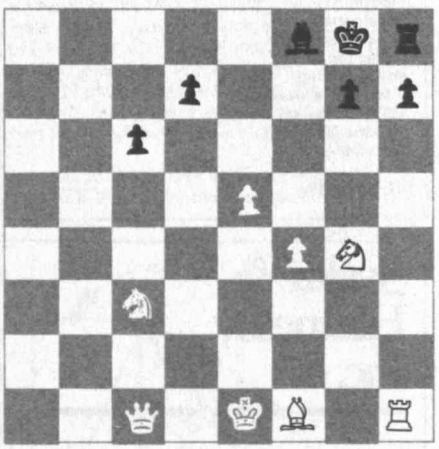
Lotteries and the Mnage Problem

Solving our **JUL 2** problem led Jim Landau to notice that the radius of the inscribed sphere (to a tetrahedron) is 1/3 the radius of the circumscribing sphere. He conjectures that the radius of the inscribed n-dimensional sphere of an n dimensional regular tetrahedron is 1/n the radius of the circumscribing sphere, where the interesting part is to figure out what is meant by an n-dimensional tetrahedron.

To answer a question of Tony Merz, Peter Lax does indeed still teach at NYU and is now in addition director of the Courant Mathematics and Computing Laboratory.

Problems

N/D 1. We begin with a chess problem from Jim Landau in which White is to move and mate in two.



N/D 2. The following problem, which first appeared in the February 1986 issue of *IEEE Potentials*, is from James Rautio: Determine, without using a computer or calculator, which is larger, e^{π} or π^{e}.

N/D 3. Matthew Fountain wants you to show that there are no positive integer solutions to:

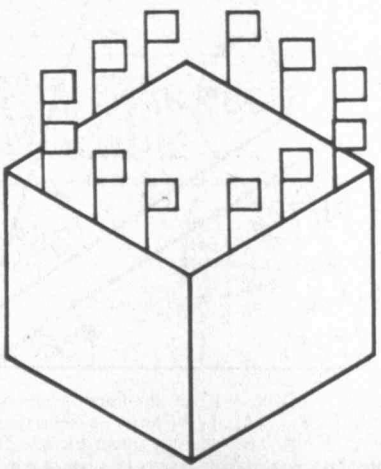
$X^3 + Y^3 + 4 = Z^3$

N/D 4. David DeWan, a lottery fan, wonders what is the probability that six random numbers chosen (without replacement) from 1 to 36 will have at least one adjacent pair (like 12 and 13, for example).

N/D 5. An anonymous Baker House alumnus wants you to solve the Mnage problem, where you have a certain number of couples to dinner and you wish to seat them at a round table, with men and women alternating and all the couples separated. How many different arrangements are possible for three couples? For four? How about ten?

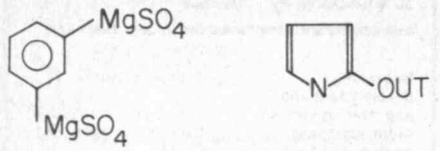
Speed Department

SD 1. Frank Rubin has a fortress laid out as a square building 100 yards on a side and 100 feet high. It stands in the middle of a flat plain. To identify the fort, the defenders want to place 3-foot by 6-foot flags on 12-foot poles around the perimeter of the (flat) roof in such a way that a person standing on the ground would see at least three flags from any direction. What is the smallest number of flags and poles required: Here is an example with 12 flags and poles.



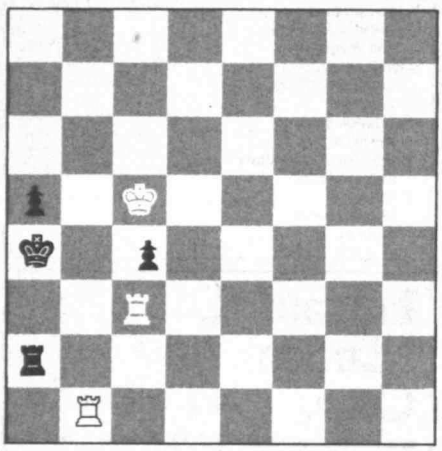
SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

SD 2. Lester Ruth wants you to name the following compounds:



Solutions

JUL 1. White is to move and mate in three.

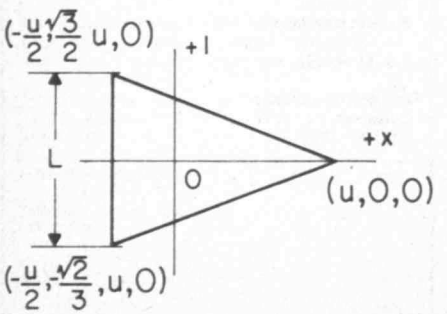


The following solution is from Mark Campbell: White's first move is Rb5. If Black responds with Ra3, White's play is Rxc4 mate. If Black responds with Ral, White's play is Rb2! Then if Black plays Ra2, White follows with RxR mate; or if Black plays Ra3, White's play is Rxc4 mate (as before). Or if Black responds to White's first move by putting R on any other square, rank 2, then:
2. Rax5 KxR
3. Ra3 mate.
Only the black rook can move; if it is sent to a3, White replies with the immediate mate, Rxc4. Black may think of Rb2; if then RxR, stalemate. But White has a reply for any move of the Black rook along the second rank—i.e.,
2. Rxa5 KxR
3. Ra3 mate.
Seeing this, Black may respond to White's first move with Ra1, to thwart the Ra3 play. But White has an ingenious answer: Rb2. Now Black cannot got back to a2 because of the RxR mate. Ra3 is terminal, because it leads to Rxc4 mate. If the Black rook leaves the first file, Whife's response is Ra2 mate.

Also solved by Elliott Roberts, Harold Solomon, Jose Figueroa, Greg Spradlin, Matthew Fountain, Robert Johnson, Robert Bart, Ronald Raines, and the proposer, Matthew Ek.

JUL 2. Find the radius of a sphere circumscribing a regular tetrahedron.

The following solution is from Edward Dawson:



Using rectangular coordinates, let one face of the regular tetrahedron lie in the X – Y plane with vertices at (u,0,0), $(-u/2, \sqrt{3}u/2, 0)$, and $(-u/2, -\sqrt{3}u/2, 0)$. Let the fourth vertex be at (0,0,h) on the z-axis, and let the center of the circumscribing sphere be at (0,0,c). The edge length $L = \sqrt{3}u$, and the distance from vertex (u,0,0) to vertex (0,0,h) is $\sqrt{u^2 + h^2}$, so that
$L^2 = u^2 + h^2 = 3u^2$, and
$h = \sqrt{2}u = \sqrt{2/3}(L)$.
The distance of the center of the sphere from the vertex at (0,0,h) is equal to its distance from the vertex at (u,0,0). Therefore,
$h - c = \sqrt{u^2 + c^2}$, and
$c = (h^2 - u^2)/2h = u/2\sqrt{2}$.
The radius of the circumscribing sphere is
$h - c = \sqrt{2}u - u/2\sqrt{2} = 3u/2\sqrt{2} = \sqrt{3/8}(L)$.

Also solved by Avi Ornstein, Daniel Morgan, Dennis White, Harry Zaremba, Greg Spradlin, Jim Landau, John Chandler, Jose Figueroa, Kelly Woods, Ken Rosato, Matthew Fountain, Norman Wickstrand, Robert Johnson, Scott Berkenblit, Robert Bart, and Winslow Hartford.

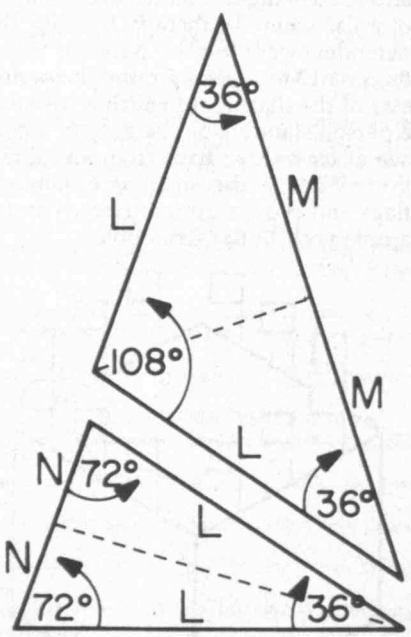
JUL 3. A (24-hour) digital watch has many times that are palindromic, such as 1:00:01, 23:22:32, :11, 2:44:42, etc. (ignore the colons). Find the two closest such times. Find the two that differ closest to 12 hours. Find the longest time span without a palindromic time.

Scott Berkenblit assumes that although ":11" is a valid palindromic time, ":01" is not (because the leading zero cannot be dropped). If this assumption is not made, :01 and :02 are consecutive palindromic times. Making the assumption gives a more interesting problem. The two closest palindromic times are 9:59:59 and 10:00:01; and 1:33:31 and 13:33:31 differ by exactly 12 hours. To determine the longest span without a palindrome, Mr. Berkenblit notes that times beginning with 16:, 17:, 18:, and 19: cannot be palindromic. The latest palindrome before 16:00:00 is 15:55:51, and the earliest one after 19:59:59 is 12:00:02, giving a span of 5:04:02.

Also solved by Avi Ornstein, Billy Eccles, Daniel Morgan, Harry Zaremba, John Chandler, Jose Figueroa, Ken Rosato, Matthew Fountain, Rik Anderson, Robert Johnson, Robert Bart, and the proposer, Nob Yoshigahara.

JUL 4. Find the exact value of (cos 36°) – (cos 72°).

Matthew Fountain sent us two solutions. The first is a cute geometric derivation; however Fountain admits that he figure this out only after the trigonometric solution revealed the answer.



Cos36° – cos72° = 1/2. In the upper isosceles triangle cos36° = M/L. In the lower isosceles triangle cos72° = N/L. Lowering the upper triangle down onto the lower triangle results in a larger isosceles

triangle with equal sides of length L + 2N = 2M. Therefore $\cos 36° - \cos 72° = M/L - N/L = (L/2 + N)/L - N/L = 1/2$.

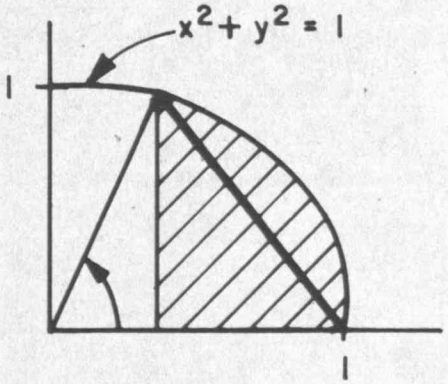
Fountain begins his trigonometric solution by noting
$\cos(2 \times 36°) = \sin(36°/2)$.
Substituting the identities
$\cos(2X) = 2\cos^2(X - 1)$ and
$\sin(X/2) = \sqrt{(1 - \cos X)/2}$ produces
$2\cos^2(36° - 1) = \sqrt{(1 - \cos 36°)/2}$.
Squaring both sides and collecting all terms on the left results in
$4\cos^4 36° - 4\cos^2 36° + (1/2)\cos 36° + 1/2 = 0$.
Dividing first by $\cos 36° + 1$ and next by $\cos 36° - 1/2$, neither of which equals zero, yields
$4\cos^2 36° - 2\cos 36° - 1 = 0$.
Noting that the first term equals $2\cos 72° + 2$, we make this substitution and obtain
$2\cos 72° - 2\cos 36° + 1 = 0$,
which is equivalent to $\cos 36° - \cos 72° = 1/2$.

Charlotte Helin adds her thanks "for all the fun I had with that innocent-looking problem." She writes, "After I solved the problem using geometry and one trigonometric identity, I suddenly realized that from the fact that $\cos 36° - \cos 72° = 1/2$, it would be possible to calculate the functions of 36° (using one trigonometric identity). So I did. I was not aware that this could be done for any angles except 30° and 45° (and their families). You remember, Hipparchus did that and made up a trig table in intervals of 7 1/2°. With a 'calculated' value for cos36°, I could produce a table in intervals of 3°. Because I was curious to see what it looked like, I calculated the value of sin 6°.

"Then, at some point when I was fiddling around with these numbers, I noticed *what the cos36° was*! $(1 + \sqrt{5})/4$ is one-half the golden ratio. So I looked phi up in one of Martin Gardner's books and found that it has been known for centuries that phi was the ratio of a side to the base of the isosceles triangle with a vertex angle of 36° and base angles of 72°. If I had been aware of this from the beginning, I could have solved for the sin 18°, then the cos36°, then the cos72° and done a little subtracting. And, of course, then I would have missed the fun of discovering all this stuff for myself. A little ignorance is sometimes an entertaining thing."

Also solved by Avi Ornstein, Daniel Morgan, Dennis White, Edward Dawson, Greg Spradlin, Farrel Powsner, Harold Solomon, Harry Zaremba, John Chandler, Jose Figueroa, Kelly Woods, Ken Rosato, Norman Spencer, Robert Johnson, Scott Berkenblit, Steven Feldman, Winslow Hartford, Robert Bart, and the proposer, Dennis Clougherty.

JUL 5. Let A be the area of the shaded curved region, and B the area of the triangle. Find $\theta \xrightarrow{\lim} 0 A/B$.



The following solution is from John Chandler (via Arpanet and Bitnet):
Since the radius of the circle is 1, the area of the shaded region is $\theta/2 - \sin\theta\cos\theta/2$, and the area of the triangle within the shaded region is $(1 - \cos\theta)\sin\theta/2$. Since both areas vanish when θ goes to zero, we must apply l'Hopital's rule to find the limit of their ratio, i.e., take the limit of the ratio of their derivatives. The derivatives, $1/2 - \cos 2\theta/2$ and $[\cos\theta - \cos 2\theta]/2$ however, also vanish at $\theta = 0$, so we must apply the rule again to get $\sin 2\theta$ and $\sin 2\theta - \sin\theta/2$, and a third time to get $2\cos 2\theta$ and $2\cos 2\theta - \cos\theta/2$. These quantities approach 2 and 3/2, respectively, for a limiting ratio of 4/3.

Also solved by Daniel Morgan, Dennis White, Edward Dawson, Harold Solomon, Harry Zaremba, Jose Figueroa, Kelly Woods, Ken Rosato, Matthew Fountain, Greg Spradlin, Robert Johnson, Scott Berkenblit Steven Feldman, Howard Stern, Robert Bart, and the proposer.

Better Late Than Never

JAN 1. Howard Stern, the proposer, notes that all solutions to date have been only asymptotic approximations and wonders if an exact solution exists.

F/M 1. Greg Spradlin found a shorter "Australian" solution.

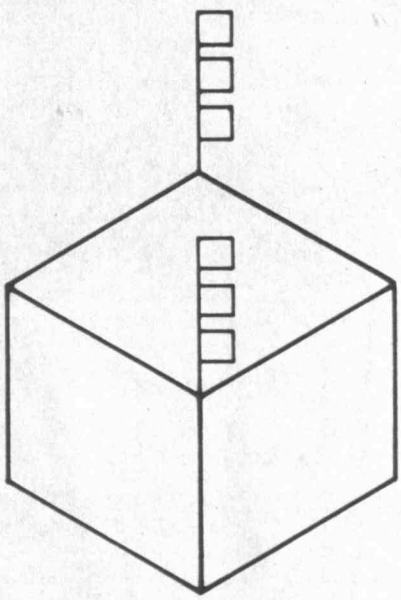
M/J 3. Naomi Markovitz has responded.

APR 2. Unfortunately Robert Bart's solution must have somehow become lost in transit. He had recognized that this problem is the classic "problem of Appolonius" and can be constructed with ruler and compass alone. There are eight exact solutions to the general case.

M/J 1, 2, 3, 4, and 5. Richard Hess has responded.

Proposers's Solutions to Speed Problems

SD 1.



SD 2. "Meta-physics" and "out on pyrrow".

DONOR'S PROFILE:

DR. AND MRS. DAVID S. SAXON

HOME: Cambridge, Massachusetts

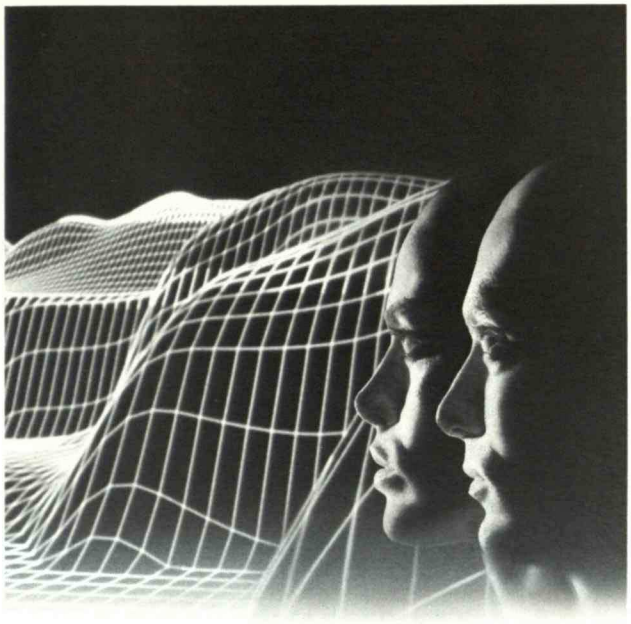
CAREER: After serving as president of the multi-campus University of California for eight years, in 1983 Dr. Saxon became the sixth chairman of the MIT Corporation. A noted physicist, he is the author or coauthor of four books on physics and was a professor of physics for more than twenty-five years. He received both his undergraduate and doctoral degrees from MIT. Dr. and Mrs. Saxon are the parents of six daughters, whose residences span half the earth: both coasts of the United States, Hawaii, and Austria.

GIFT OF CAPITAL: Life Income Trust, with the remaining assets designated for unrestricted endowment.

QUOTE: "In trying to sell other people on planned giving, I sold myself," Dr. Saxon said. "I saw how well MIT manages these trusts." When asked why he chose to make an unrestricted gift to endowment, he answered, "We need to provide our successors with maximum freedom in terms of resources. Building MIT's endowment is the best way of doing this."

For more information about gifts of capital, call D. Hugh Darden or Frank H. McGrory at MIT (617) 253-3827.

Photo: Jim Harrison



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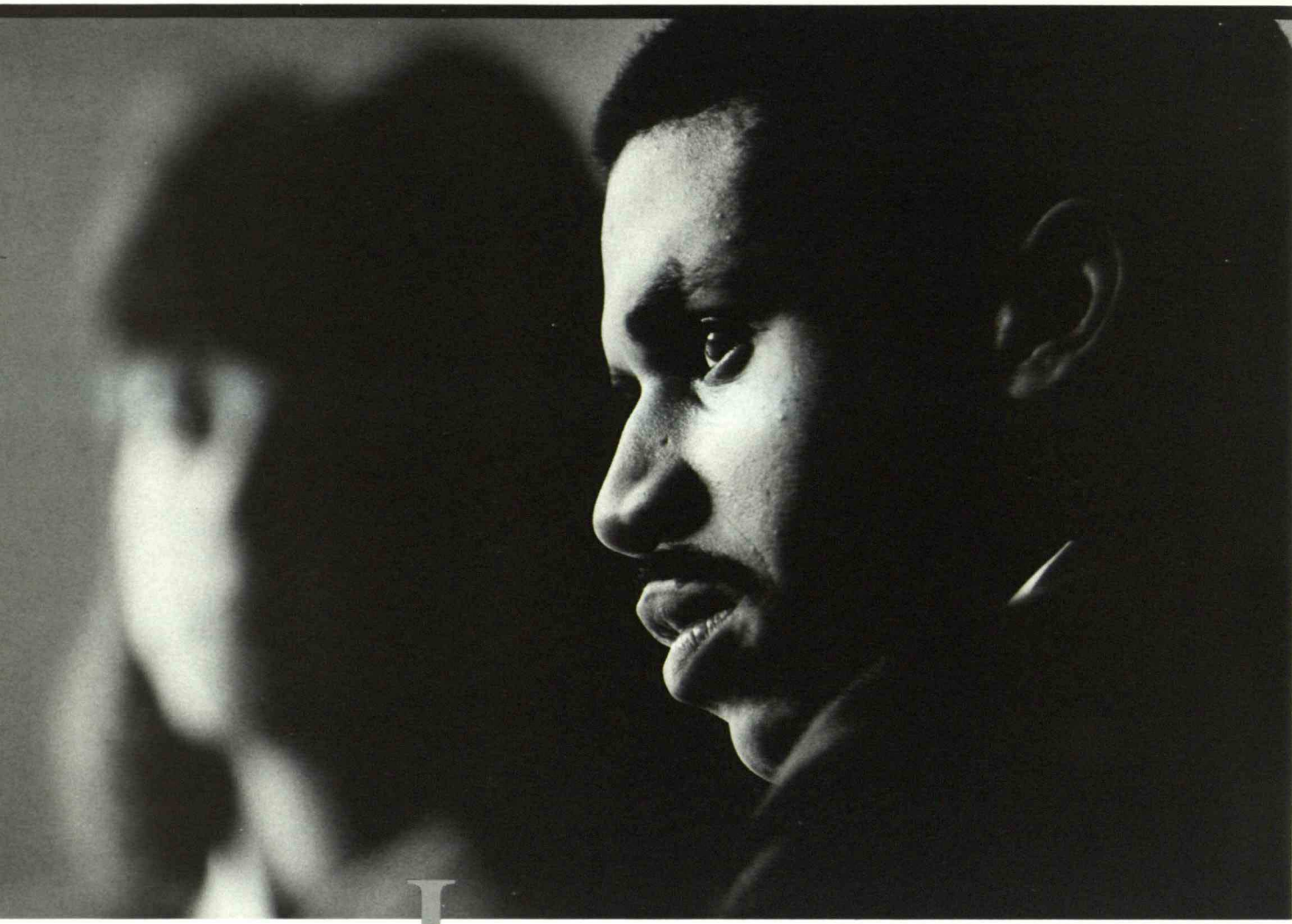
Darryl Greene knows that teamwork is the key to winning.



Just a year out of school, Darryl Greene is responsible for supplies and services that support 14 major plants in GE's Lighting business.

What makes this young engineer so successful, so fast? His dynamic sense of teamwork is a big factor. He's got the confidence to interact with people at all levels. His personality inspires trust. He knows how to act like a leader, so his colleagues will act like a team.

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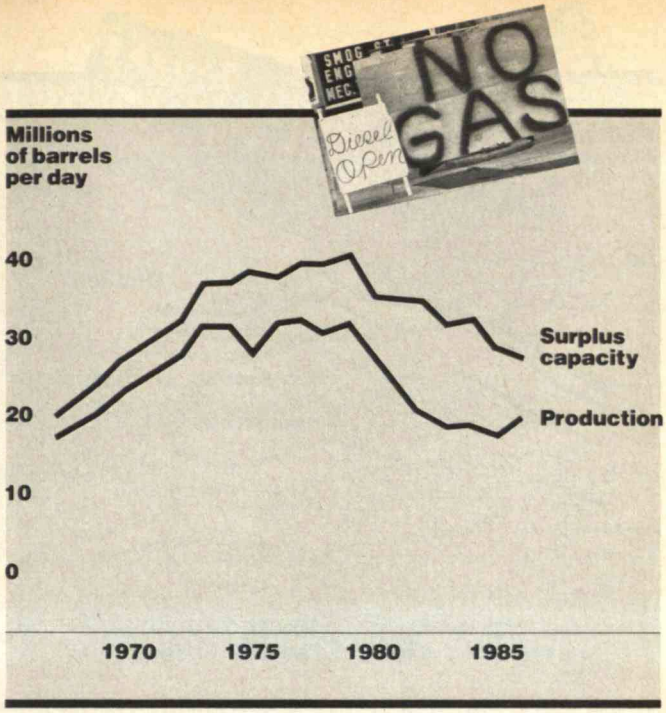


OPEC's surplus oil capacity—the difference between production capacity and actual production—has fallen from over 14 million barrels a day in 1982 to less than 8 million. World surplus capacity is not much higher and could drop as consumption rises. This means that a disruption in supply would be harder to absorb and more likely to lead to a crisis.

to its 1967 borders. There may have been economic considerations, too—the embargo occurred while Persian Gulf exporters were seeking large price increases. They must have been aware of the impact of production cuts, though it is impossible to know how important this factor was. Sometimes political disruptions are not aimed directly at consumers but at a third party, as in 1979 when radical Muslims struck against the Shah of Iran and stopped oil production. Consumers have little ability to influence such disruptions, since they are not even directly involved.

A host of factors may separate a minor disruption from a major crisis, and the actual amount of oil supplies lost may not make the critical difference. Consider the third largest oil-supply disruption, which occurred in September 1980 when Iraq invaded Iran. The Iran-Iraq War reduced oil supplies by 4 million barrels a day, but prices increased only 25 percent and returned to pre-crisis levels after nine months. It was merely a ripple on the tidal wave of the 1979 oil crisis, which had tripled oil prices. Yet that crisis involved just 6 million barrels a day for four months, and a long-term loss of 3 million barrels a day, all replaced by other suppliers.

One important difference between a crisis and a disruption involves the amount of surplus capacity the market has to replace lost supplies. By the time the Iran-Iraq War broke out, the price rise from the 1979 crisis had caused world demand to fall by about 5 million barrels a day. This left considerable surplus capacity at all levels of the industry—in production, transportation, refining, and distribution—to replace supplies cut off by the war, and substantially reduced the impact on prices.

Another important factor that can help cause a crisis is a buildup of oil inventories. When Iranian oil stopped flowing in January 1979, oil companies and consumers feared that other oil-producing governments might suffer the fate of the Shah and that the market might experience a far worse shock. Oil companies therefore built up their inventories by as much as 3 million barrels a day, in effect increasing demand by that amount. The Muslim radicals' takeover of the mosque at Mecca in November further encouraged buyers to stockpile oil. Governments refused to release the oil they controlled in strategic reserves, and even ordered companies to increase their oil inventories. In contrast, by the time of the 1980 Iran-Iraq War, storage tanks were full worldwide, and companies were forced to reduce purchases for lack of storage space, in effect reducing demand.

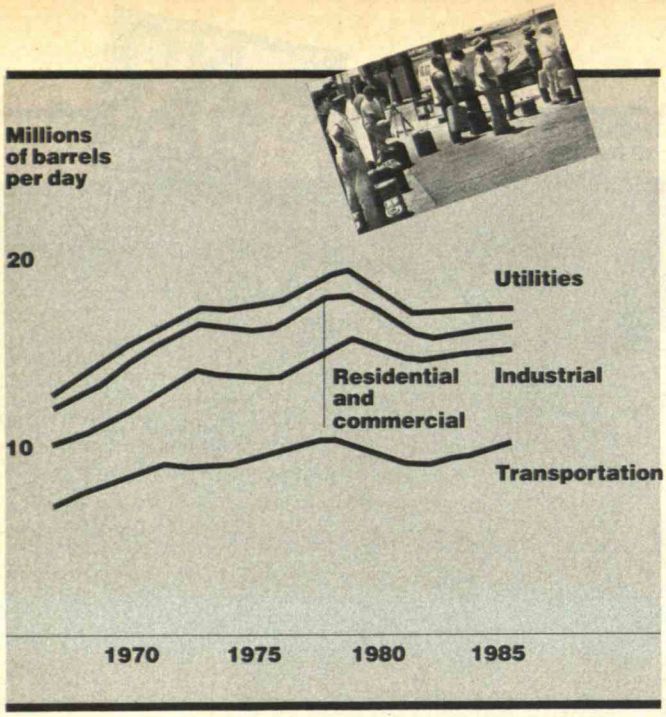
Poor information about oil supplies can aggravate a crisis. In 1979, as consumers switched to coal and natural gas and the economy slowed, oil consumption decreased. But because of the time needed to gather petroleum industry statistics, it took several months to ascertain this trend. Since new supplies were extremely difficult to find, oil companies would not cancel purchase arrangements with oil-producing nations just because they had bought a surplus for a month or two. This helped maintain demand.

A panic mentality made purchasers bid prices up on the oil market. With their supplies cut back, the majors reduced deliveries to large customers such as Japanese oil companies, which had no supplies of their own. This forced these customers into the market to compete with the major oil companies for supplies. The spot market in crude oil—oil not tied up by long-term contracts—had made up only 5 percent of total market, but now almost none was available.

Changes in the World Oil Market

The biggest mistake in planning for emergencies is blindly assuming that past problems will recur. After the 1973 Arab oil embargo the industrialized countries set up the International Energy Agency (IEA) mainly to deter the use of oil supplies for blackmail.

DIAGRAMS: TOM BRIGGS DESIGN



Unlike utilities and industries, the transportation sector cannot reduce oil use in a crisis by switching to natural gas or coal. Yet transportation accounts for an increasing proportion of U.S. oil consumption—up from 54 percent in 1979 to 63 percent in 1986. Increases in Europe and Japan have been even more dramatic.

The next oil crisis, however, was aimed at the Shah of Iran and beyond the scope of the IEA. Changes in the market structure since the last oil crisis should influence the next, but policymakers have focused primarily on preventing an inventory buildup like that of 1979.

One of the most significant changes in the oil industry is its decline in surplus capacity, which could make a crisis more likely. Most industries operate at 85 to 90 percent of their maximum capacity. The 10 to 15 percent surplus allows managers to increase production if demand rises and to offset the effects of maintenance shutdowns, supply shortages, or strikes. Demand is normally the greatest uncertainty in the petroleum industry—it depends on unpredictable factors such as the level of economic growth, the price of competing fuels, and the weather.

The oil price increases of the 1970s reduced demand and left 14.5 million barrels a day of surplus oil production capacity in the early 1980s. However, maintaining surplus capacity—idle wells, tankers, and refineries—is expensive. Not surprisingly, the owners of this equipment have allowed the excess to decline. Since 1979 refinery capacity has fallen by 14 percent in the United States and 29 percent in Western Europe. About one-third of the world tanker fleet's capacity has been scrapped. Most important, OPEC production capacity has dropped by 13 million barrels a day since 1979. According to the best estimates, the world now has a surplus capacity of about 9 million barrels a day—a rough equivalent to the level at the time of the Iranian oil crisis. As demand for oil increases in response to relatively low prices, this surplus could decline rapidly.

The principal ways in which we use oil could aggravate a crisis. In 1979, by switching to coal and gas, electric utilities were responsible for more than half of the reduction in U.S. oil demand, thereby easing pressure on the market. But if a crisis occurred today, the utility sector could not make such a significant contribution because it has already reduced its oil consumption by two-thirds since 1979. The amount of oil needed for transportation has correspondingly risen. The United States used 54 percent of its oil for transportation in 1979, but 63 percent in 1986, and the increases in Europe and Japan have been more dramatic. Since coal or gas cannot be used for transportation, the developed nations are less able to reduce demand for oil than they were during the oil crisis of 1979.

Other factors may work to reduce the size of a future crisis, such as the diversification of oil production. In 1973, OPEC produced 56 percent of world crude oil and accounted for 87 percent of world exports. By last year, these figures had dropped to 33 and 56 percent. As a result of falling demand for OPEC oil, no OPEC country today is producing the 6 million barrels a day that Iran did in 1978. Britain, Norway, Canada, Australia, Brazil, India, and many smaller countries have increased production.

Since oil production is more widespread, any future disruption, which would probably be concentrated in one region, is likely to have a lesser effect. And since today's non-OPEC producers are small and numerous, their ability to coordinate sales like a cartel is insignificant. Though they raise their prices quickly when the market tightens, these producers have to drop them when the market weakens. In addition, the United States, Canada, and Australia have all decontrolled oil prices. In a crisis prices will rise faster, encouraging consumers to conserve fuel and reducing demand.

The oil producers' debts will also tend to soften the next oil crisis. Producers are better able to turn a disruption into a crisis if they are comfortable enough financially to reduce production and keep prices high. In 1973, oil exporters had experienced several years of rapidly growing prices and sales, so they could afford to cut production. By 1979, most OPEC countries were either spending their profits

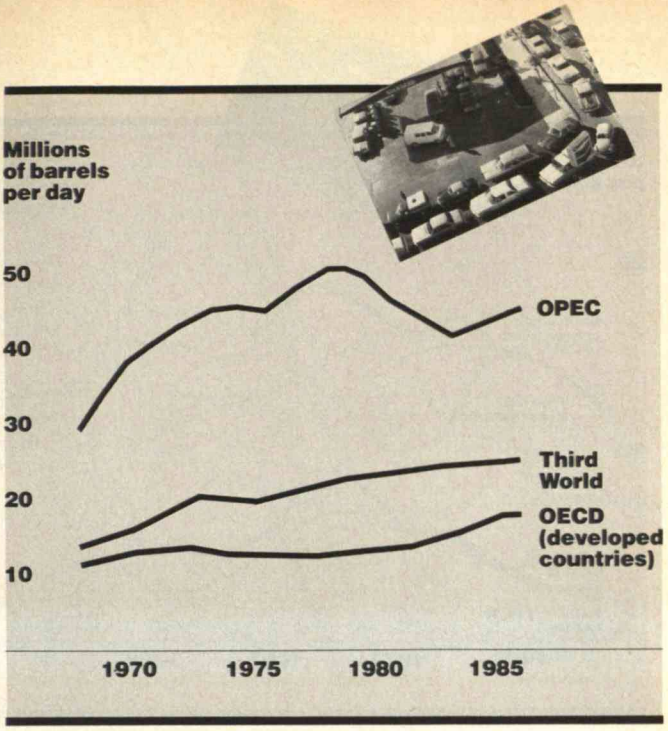
from the 1973 price increase or going slightly into debt. Now that most of them are deeply in debt, even several months of prices at two or three times current levels would not provide a financial cushion.

Conservation by consumers will further cut the economic impact of an oil crisis. In the United States, gross national product (GNP) has grown by 15 percent since 1979, while oil consumption has fallen by 14 percent and imports by 35 percent. The impact elsewhere is similar, although imports have generally not fallen as much. The use of only 75 percent as much oil and 56 percent as much imported oil per unit of GNP would substantially lessen the economic impact of any given oil-price increase.

Still other factors will have a mixed influence on the next oil crisis. The major oil companies' control over the oil market has eroded. Before the 1973 oil crisis, the eight largest oil companies controlled as much as two-thirds of the world market and the majority of internationally traded oil. Now their share has been cut in half. Large consumers, including Japanese companies such as Mitsubishi, are purchasing crude oil directly. Small independent traders seek to make profits by buying and selling oil. OPEC national oil companies have established refineries abroad and are selling directly to consumers. For example, Petroleos de Venezuela has established refineries in the United States, and the Kuwait Petroleum Company has done the same in Europe.

The majors' loss of control over the market may make it harder to manage a crisis. During the oil crises of the 1970s, they performed the lion's share of work in redistributing the available oil. Next time the private sector will find it more difficult because of the sheer number of companies involved and the myriad opportunities to hide supplies. An oil company might want to reduce sales to one customer or nation to help another with a greater shortfall, but it may not know whether either recipient has arranged for oil from another source. The IEA plans to gather and disseminate information about oil availability and trading, which could be its most important contribution to managing a crisis.

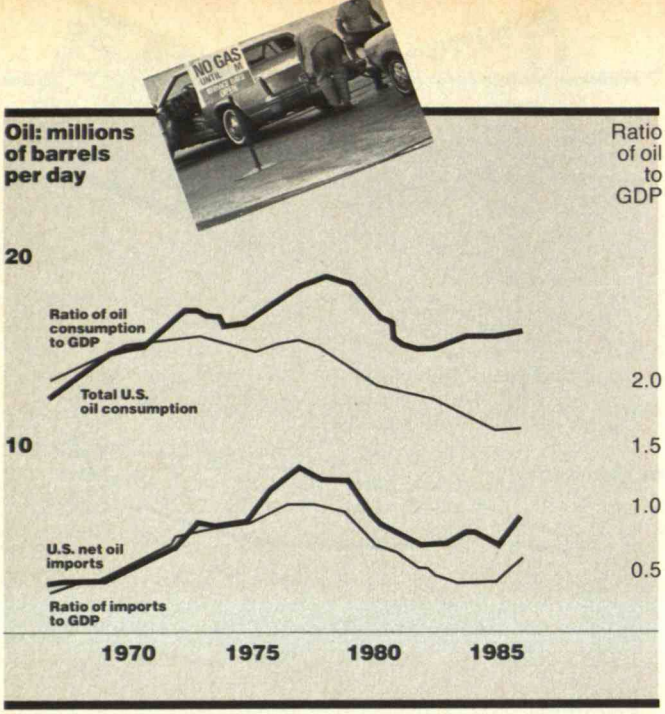
On the other hand, the increase in the amount of oil purchased on the spot market without long-term contracts could help soften pressure on prices. During the 1970s, the spot market accounted for only 5 percent of all production. When Iran and others canceled or reduced contracts in 1979, oil companies scrambled to buy that 5 percent. Intense bidding for a small amount of oil helped increase prices. Today as much as half of the oil is traded on the spot market, so arranging for new supplies will be easier during a disruption.



OPEC produced 56 percent of world crude oil in 1973 but only 33 percent in 1986. Developed nations, including Britain, Canada, and Norway, have increased oil production, as have India, Brazil, and many smaller Third World nations. More dispersed production means that any future disruption, which would probably be concentrated in one region, is likely to have a smaller effect.

An organized futures market in petroleum is one of the most significant developments since the last oil crisis, but its impact is hard to gauge. Participants in the oil market, be they multinational oil companies or individual investors, can buy or sell a contract for a given quantity of oil at a fixed price, to be delivered on a specified date up to several months off. This means that buyers can receive oil at a guaranteed cost without building up physical inventories. During a disruption, this could help prevent inventory buildup, reduce demand, and keep prices low. Unfortunately, companies can also keep smaller inventories before a disruption. This makes them more vulnerable to shortages. Moreover, the futures market invites mob psychology in bidding up prices during a disruption.

What do all these factors add up to? In essence, more "mini-crises" than in the past. It will take a smaller disruption to create a price hike because of the decline in surplus capacity, and the increasing percentage of petroleum used for transportation will make it harder to reduce demand. The greater role of traders and futures markets means that market psychology can create rapid price swings, such as occur on the stock market. Since the oil market is more competitive than ever, exporters will probably raise prices more quickly than in past disruptions.



The U.S. gross domestic product (GDP) has grown from $3.2 trillion in 1979 to $3.7 trillion today (in constant 1982 dollars). Yet oil consumption has dropped from 18.5 million barrels a day to 16.3 million barrels. The reduction in the amount of oil used per unit of GDP is roughly 25 percent—enough to substantially lessen the economic impact of any oil price increase.

On the positive side, future crises should cause less economic damage since oil consumption is so much lower. The smaller size of a typical disruption, owing to more widely dispersed production, will reduce the impact. And the weakened financial conditions of OPEC nations will make it hard for them to sustain price increases, especially if the larger members such as Saudi Arabia continue to oppose high long-term prices.

What to Do About Crises

What are a nation's objectives in dealing with energy crises? First is to deter blackmail—the intentional disruption of oil supplies for political or economic purposes. Second is to reduce the likelihood of a disruption turning into a crisis. Failing that, mitigating the economic impact of a price increase has top priority.

Policies to achieve these objectives generally fall into three categories: direct governmental action, such as filling the Strategic Petroleum Reserve (SPR); economic policies, such as an oil tax to reduce consumption or a tariff to reduce imports; and planning, such as IEA simulations of oil crises.

The SPR contains 525 million barrels of oil, enough to replace all of America's imports for three months or more. It is capable of delivering this oil at the rate of 3 million barrels per day, which would make it the fourth largest oil producer in the world—albeit for a short period—after the Soviet Union, the rest of the United States, and Saudi Arabia.

The SPR is the cheapest and potentially most effective energy security policy. It not only deters blackmail; in the event of a disruption it can replace crude production capacity, reducing the tendency for oil companies and consumers to hoard. This should hold down demand and prices.

But the SPR has its problems. For one thing, it can still deliver only half the capacity lost during the height of the Iranian oil crisis, and less than two-thirds of the largest production cut during the Arab oil embargo. Depending on the magnitude of a disruption, the SPR could be overwhelmed. The world's total ability to offset an oil-supply disruption is not much greater—the SPR accounts for two-thirds of all government-controlled oil inventories and producing capacity. And Americans could oppose releasing oil from the SPR since it would lower prices the world over and let nations that do not have their own strategic reserves save money at the expense of the United States.

Even if consuming nations cooperate in managing an oil disruption, a short-term addition to supply from the SPR may not solve the problem. The Iranian Revolution and the Iran-Iraq War combined introduced a long-term loss of 5 million barrels of oil-production capacity per day. Today there is enough surplus capacity for the market to conceivably cope with a loss of such magnitude. But as surplus capacity declines, that may no longer be the case. If officials draw the SPR down rapidly during a few months of political turmoil, then abruptly stop the oil flow upon acknowledging a long-term loss of capacity, they will have accomplished little. In such a case, the role of strategic inventories must be to smooth the transition and possibly delay the price increase while consumers implement alternative strategies.

The other major problem with the SPR is that there is no guarantee of its timely use. Just as they did in the Iranian oil crisis, governments could hoard oil during a new disruption, especially a political one in which uncertainty about future supplies is greatest. Most governments, in fact, have been unwisely cutting their inventories over the last few years of oil glut.

The obvious solution is to increase the size of the SPR to provide greater insurance and make the government more comfortable about releasing oil. At the same time, the United States should step up its

efforts to persuade allies to build their own strategic inventories.

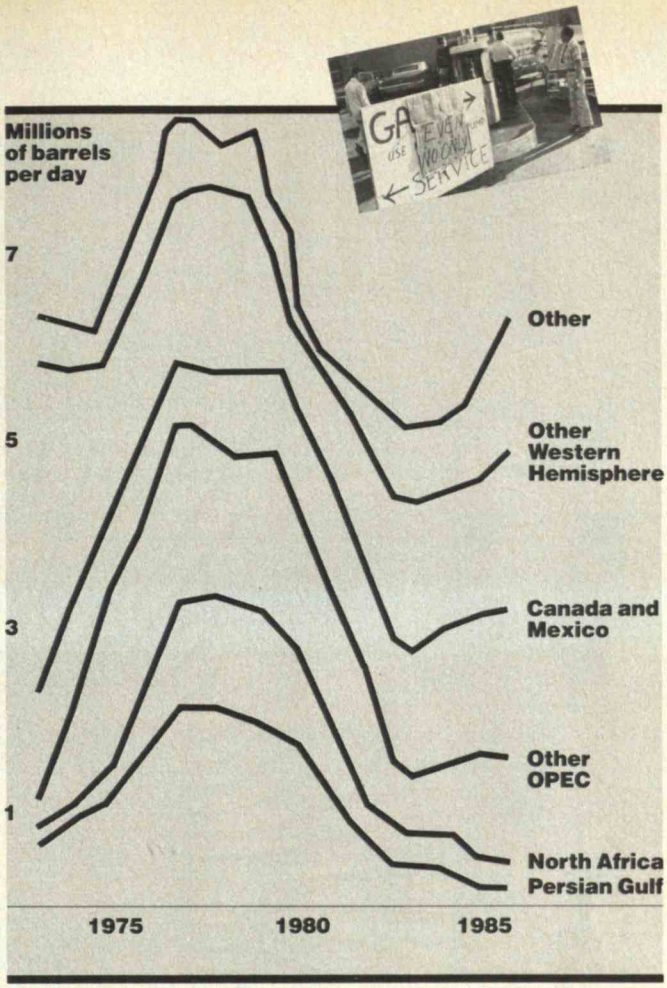
Should We Impose Oil Taxes?

The United States could afford to increase petroleum taxes. To reduce consumption as well as raise revenue, many nations, including Japan and most of Europe, levy significantly higher oil taxes than we do. Since the United States is a major oil producer, an import tariff would have the added benefit of spurring production and reducing imports. The oil price crash of 1986 increased political pressure for such a tariff because it would help oil companies with domestic wells and regions where energy production is important. To stabilize domestic oil prices, groups including the Independent Petroleum Association of America—a business group representing small oil companies—are promoting a variable tariff that would rise as oil prices drop on the world market, and fall as they rise.

An oil import tariff would mainly reduce the economic impact of an oil price shock by lowering petroleum consumption and, especially, imports. The less oil the United States imports, the less money consumers must send overseas when the price increases. Sending money from the Northeast to the Southwest does have negative economic consequences, but they are smaller than those of sending the money overseas.

A variable oil import tariff to achieve price stability sounds appealing but would be counterproductive. It would in effect tell OPEC nations that their most important market was charging a minimum price. They could either receive the money or allow the U.S. government to have it. This would be a powerful incentive for them to raise their official prices and allow the world-market price to fluctuate above this floor.

Most of the dispute over import tariffs arises from negative effects that, unlike those from the SPR, are substantial. If an oil price increase during a crisis depresses our economy, do we really want to do that to ourselves? Certainly a massive, immediate increase to bring prices back to pre-1986 levels is not warranted. However, a phased-in tariff would disrupt the economy less, and planners would know more about future prices. Oil producers could invest in production, refining, and transportation equipment with more confidence that they would see a return on their investment. Consumers could make more rational decisions about buying equipment that uses energy. Unfortunately, phasing in the tariff would reduce its near-term economic benefits, since many idle wells could not initially be put back to work.



The United States imports much less oil from OPEC today than it did during the late 1970s. However, Mideast oil costs less than $1 a barrel to produce, while U.S. oil costs $10 to $15 a barrel. Given today's relatively low oil prices, U.S. drilling could decline, leaving the Mideast to expand production and garner more of the market. This could aggravate a crisis.

The main political obstacle to an oil import tariff is that it would hurt regions that do not produce oil. Although ownership in oil companies is largely held by investors in non-producing areas, low-income people in the Northeast would hardly be cheered by that fact. Still, the government spends huge amounts of money to keep farm prices high, while low-income people of course continue to require food. The government is quite capable of providing assistance based on need without altering overall economic policies.

The benefits of a moderate oil import tariff appear to outweigh the increased energy costs to some parts of the country. And such a tariff would create a favorable side effect: It would reduce the burning of

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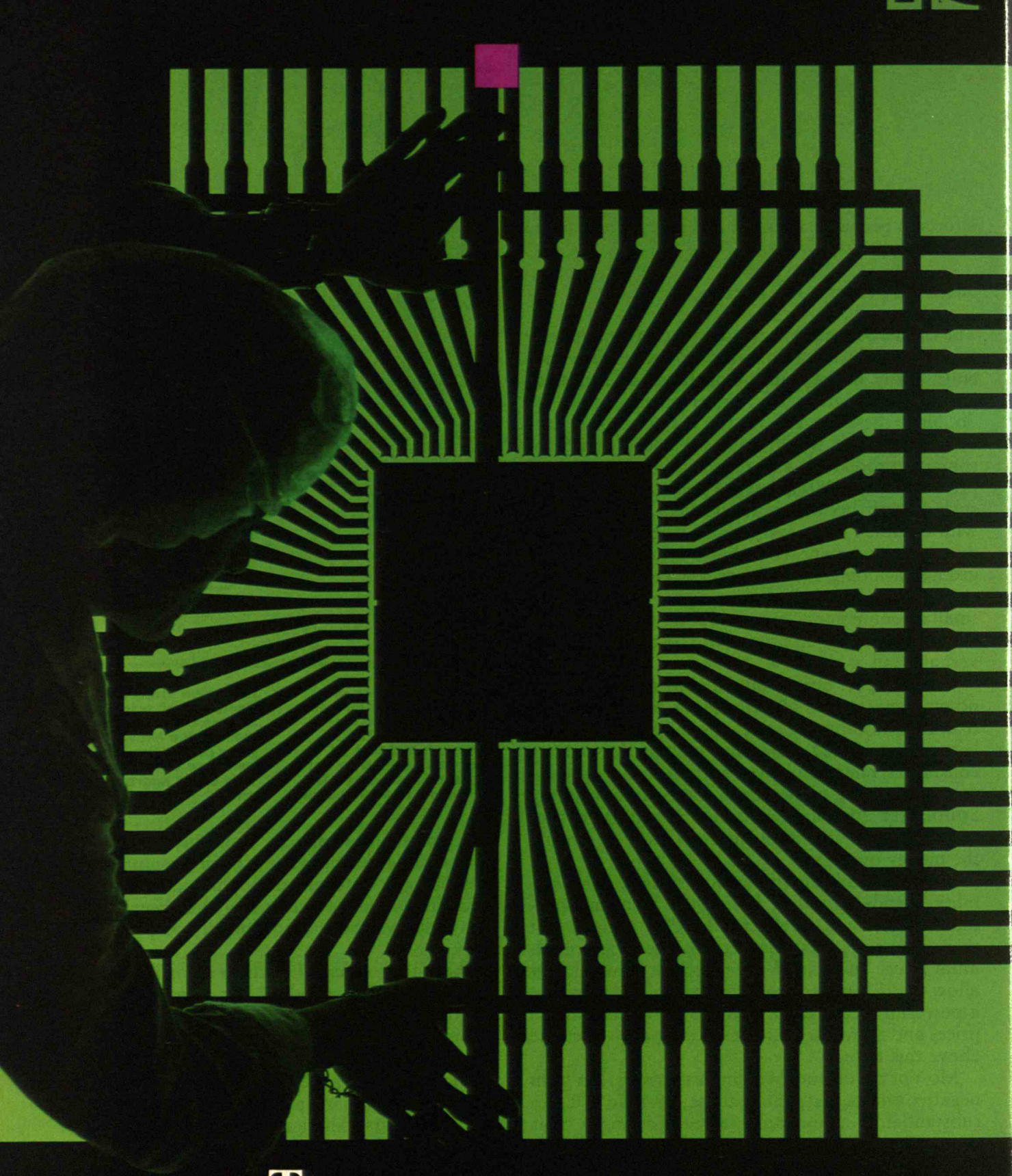

The U.S. semiconductor industry has woven its troubles into a theme of jobs, competitiveness, and national security, but its aim is old-fashioned protectionism.

National Security and the Semiconductor Industry

CONSIDER the woes of the U.S. semiconductor industry. Once the undisputed leader in state-of-the-art microelectronics technology, it is now clinging to a precipitously declining share of the $30 billion world market for mass-manufactured chips. Since 1978 Japan has increased its cut from 28 to 50 percent, while the United States has dropped from 55 to 44 percent. In 1985 and 1986, during a worldwide recession in semiconductors, U.S. companies lost more than $2 billion, putting more than 50,000 employees out of work.

Especially in key sectors of the chip market, the United States has lost ground. In 1975 U.S. companies controlled 90 percent of the world market for dynamic random access memory (DRAM) chips, the ubiquitous integrated circuits that allow computers to store, remember, and change data. By 1986 that share had shriveled to 5 percent as U.S. companies took a beating from Japan, other Pacific Rim countries, and even from the Europeans.

The implications of a downturn in the semiconductor industry reach deeply into the entire U.S. economy. Semiconductors are integral to the electronics industry, which in 1986 accounted for 15 percent of the U.S. industrial output in 1986—$250 billion. The chip industry's economic importance has enabled it to appeal to Washington for help in dealing with foreign competitors, resulting in last year's semiconductor pact with the Japanese government. Japan agreed to end alleged unfair price cutting on semiconductors and open the Japanese market to U.S. producers. This spring, when the United States claimed that Japan was not living up to the pact, President Reagan slapped steep import tariffs on a variety of Japanese products.

Despite this intervention, the fortunes of the semiconductor industry did not improve appreciably, and its latest calls for help invoke a more ominous threat: national security. The semiconductor industry has managed to weave that issue into a theme that includes jobs and competitiveness—but the theme is little more than a euphemism for protectionism.

The new argument runs like this: Leadership in semiconductor technology is a "force multiplier." That is, high-technology U.S. weapons offset whatever quantitative advantages the Soviets possess. Semiconductor applications enhance U.S. military capabilities particularly in early warning, air-defense, and air-to-surface-attack systems; conventional artillery and tanks; and naval surface warfare. With the fabrication, assembly, and packaging of semiconductors shifting rapidly to other countries, most notably those of the Pacific Rim, the United States could be prevented from obtaining semiconductors due to war or deteriorating relations with allies.

Until recently, the Pentagon seemed unconcerned with the national-security implications of foreign-produced electronics. To save costs or reward allies, the Department of Defense (DOD) last year awarded more than $9 billion in contracts to foreign firms—about 6 percent of total procurement. In October 1986 the Air Force Military Airlift Command announced the purchase of a major computer system of foreign origin to handle flight scheduling and weather information. This $33 million contract represented the first major military purchase of a largely foreign-made computer system. Although it was from Honeywell, the system uses central processors, semiconductors, and circuitry from Nippon Electric Corp. (NEC), the world's largest chipmaker.

DOD showed more interest in the semiconductor/national-security link in late 1986 when Fujitsu revealed plans to purchase 80 percent of Fairchild Semiconductor for $200 million. The arguments presented in the Fairchild-Fujitsu affair epitomize how the semiconductor industry could enlist not only the White House and Congress but also the Pentagon in

BY DORINDA G. DALLMEYER

PHOTOS: WEST LIGHT, CHUCK O'REAR

its battle with foreign competition. Industry opposed the sale because it would bring a strong competitor into the domestic market, one not restricted by quotas or tariffs aimed against foreign manufacturers.

The second-largest seller of chips to the military, Fairchild manufactures semiconductors for advanced computers, military systems, and nuclear-weapons communication systems. Thus, when the sale was proposed, Commerce Department press secretary B. Jay Cooper claimed that it put "vital national interests at stake." While some called for prohibiting the sale outright, others proposed that the sale go forward with certain provisos. Officials from DOD and the U.S. Trade Representative's office proposed that Fairchild be blocked from making military technology available to Fujitsu. Treasury and Commerce Department officials suggested that military contracts be denied to the merged company, that transfer of technology to Japan be limited via U.S. export controls, or that the defense portion of the firm be split off.

The Commerce Department claimed "vital interests were at stake" when Fujitsu wanted to buy Fairchild Semiconductor.

Sen. Howard Metzenbaum (D-Ohio) led the congressional outcry, postulating loss of jobs and citing potential antitrust violations. With then Commerce Secretary Malcolm Baldrige and Defense Secretary Caspar Weinberger threatening to block the sale, Fujitsu withdrew its offer in March. Six months later, National Semiconductor shocked analysts when it picked up Fairchild for a bargain price of $122 million, making National Semiconductor the sixth largest chipmaker in the world.

In any case, national security was probably never at stake. Some 95 percent of Fairchild's products are available to DOD through other domestic suppliers. As for potential job losses, Fairchild has been foundering for some time, having laid off 20,000 workers over the last seven years. An infusion of capital from Fujitsu could have safeguarded remaining jobs or even increased employment. After the purchase by National Semiconductor, the future of Fairchild's remaining 9,000 employees was notably vague. And while any potential antitrust violations would be subject to scrutiny under existing laws, the semiconductor industry has been calling these regulations too strict—not too lax—in inhibiting cooperative R&D efforts.

Nor does it make sense that a Japanese-owned corporation would deny the United States the products already made here since Fairchild needs the business. Finally, Schlumberger Corp., a French company, had owned Fairchild since 1979. As Robert Christopher, author of *Second to None: American Companies in Japan,* noted, "Any suggestion that the French are more responsive to American defense concerns than the Japanese is patently absurd." Clearly, the U.S. semiconductor industry was interested in protection, not national security.

Enter the Defense Department

The same issues that arose in the Fujitsu-Fairchild case underlie the industry's proposal that the government subsidize Sematech, a new consortium intended to restore U.S. competitiveness by the early 1990s. The project grew out of a Defense Science Board (DSB) task force established late in 1985 by Donald A. Hicks, undersecretary of defense for research and engineering. The task force was charged with assessing the state of the semiconductor industry to determine if its decline affected national security and, if so, to recommend appropriate DOD actions.

Reflecting sympathy for the national-security argument, the task force's 1987 report shows how important semiconductors are to the military. DOD spends approximately 35 percent of its R&D and procurement funds on electronics. On the other hand, the military, once the largest customer for semiconductors, is not so important to the industry. DOD now accounts for less than 10 percent of semiconductor sales and only about 3 percent of the quantity of chips.

Having documented the importance of semiconductors to the military, the task force analyzed the factors that have contributed to the decline of the domestic industry. The basic cause appears to be fundamental differences between the Japanese and U.S. economies, especially the higher cost of investment capital in the United States. This occurs in part

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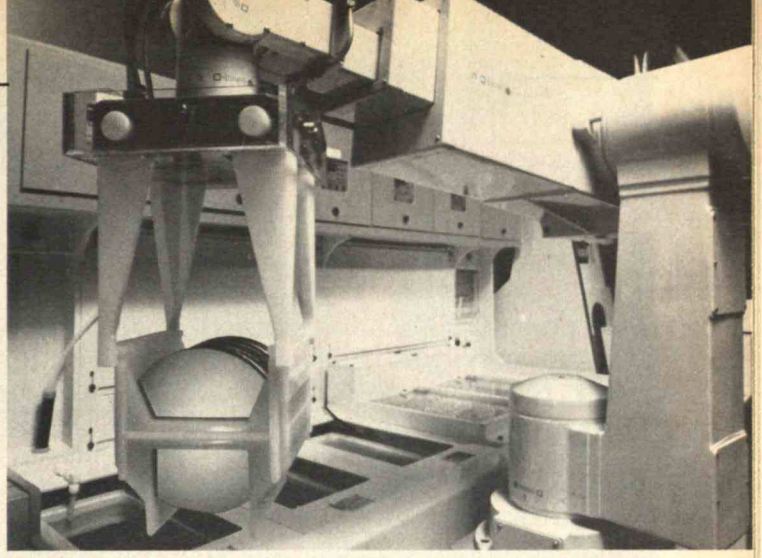


Semiconductor manufacturing is highly mechanized. Here an Intel Corp. robot processes a silicon wafer through chemical baths.

because Americans save only about 5 percent of their income compared with the Japanese average of 15 percent. In addition, Japanese semiconductor companies belong to huge conglomerates. The major banks that head these organizations are ready sources of low-interest R&D funds. Japanese semiconductor companies reinvest twice as much—as a percentage of sales—in manufacturing technology as their U.S. counterparts and about 10 percent more on semiconductor R&D. Indeed, because the semiconductor pact increased the price of chips, Japanese companies have profited, and Japan is reportedly spending its increased cash on more R&D.

A second and related structural difference is that Japanese investors accept a much lower and slower return on investments. During industry reversals, stockholder demands mean that U.S. companies strive to maintain short-term profitability, while Japanese companies preserve market share for future recovery.

Even the basic internal structure of its industry favors Japan, where vertically integrated companies predominate. Japanese chipmakers design and fabricate massive quantities not only for export but also for their affiliates to incorporate into finished products. The U.S. industry is fragmented into high-volume merchant companies that sell chips to other manufacturers, a few Japanese-style vertically integrated companies (like NCR), semi-custom manufacturers (like LSI Logic Corp. and VLSI Technology, Inc.), and design or process specialists (like Brooktree Corp.). This diversity, while appealing to American pride in independence, impedes the large-scale cooperative R&D needed to compete.

The report accurately places the onus for its misfortunes on U.S. industry itself. When Japanese industry, along with government and academia, adopted a sound long-term strategy to target and dominate certain markets, the approach was equally available to the United States. As the report states, the United States was "once in a position to enforce virtually any semiconductor market strategy it chose, having invented the technology, controlled the leading-edge research, dominated the relevant education, held the largest world market share, and consumed the majority of the product."

The task force minimized the impact of two common explanations for Japan's success. It viewed wage-rate differentials between the United States and the Pacific Rim as no longer important. Moreover, it concluded that the practice of dumping—selling chips at less than fair market value—that led to the export quotas earlier this year was not a major cause of the U.S. decline.

The report also indicates that it is premature to say that national security is threatened, because DOD has no idea of the extent to which foreign semiconductors have been incorporated into U.S. military equipment. Most program offices keep no records of origin other than the label showing where equipment was finally assembled. A survey of 10 air force systems indicated that only about 3 percent of the semiconductor components were foreign, but the task force recognized that this was inconclusive data and suggested that DOD trace its materiel sources more accurately.

Sematech: The Main Act

Based primarily on its conclusion that the fragmented structure of the U.S. semiconductor industry inhibited R&D, the Defense Science Board task force recommended that DOD fund, at $200 million annually, a government-industry collaboration to develop advanced manufacturing technology. The assumption was that Japanese leadership relies on its ability to mass produce chips better and more cheaply, not an ability to produce higher-tech chips.

Shortly after the task force released its recommendations, the chipmakers' leading trade group, the 45-odd-member Semiconductor Industry Association (SIA), proposed a similar research consortium, which it dubbed Sematech (short for *se*miconductor *ma*nufacturing *tech*nology.) Some of the people pushing Sematech in the private sector also served on the DSB task force, including former DOD official Larry W. Sumney, now Sematech's interim managing director.

Consortium members will supply money and staff to Sematech in exchange for access to the resulting manufacturing technology. To fund the venture, the SIA is seeking $125 million annually from industry and a matching amount from the federal govern-

The purpose of Sematech is to find ways to mass-produce high-quality chips more cheaply than Japanese firms do.

ment, primarily DOD, for six years. The minimum corporate assessment will be $1 million per year for at least four years. As of September, 13 chip producers—including Advanced Micro Devices, Digital, Hewlett Packard, IBM, National Semiconductor, and Texas Instruments—had agreed to participate. But final agreement to join Sematech hinges on substantial government funding and approval by company management.

The consortium, launched in March 1987, will focus initially on developing DRAM manufacturing technology. The current state of the art is a 1-megabit chip—a chip that holds 1 million bits of information. Sematech plans to increase the DRAM capacity to 4 megabits immediately and create a 64-megabit DRAM by the early 1990s.

By supporting Sematech in what could be a futile race against Japan, the Defense Department may repeat earlier mistakes.

Although a high-volume production line is the best way to test manufacturing techniques and drive down costs, Sematech will combine a medium-scale plant with elaborate software programs. These would give manufacturers the flexibility needed to produce complex and customized chips. The SIA rejected the option of having Sematech manufacture commercial quantities. The decision for small volume was reportedly a concession to obtain IBM's support for the project. IBM feared it would be pressured into buying Sematech's chips, even if other chips of better quality or lower cost were available. Chips coming off the production line will be used only in testing and quality control—none will be sold.

Real Problems, Wrong Answers

While the need is undoubtedly real, the proposal for a government-industry collaboration is the wrong answer. Sematech will focus on the memory-chip market, which the Japanese already dominate—and, given the direction and extent of their R&D, will continue to dominate. From a commercial point of view, DOD could better strengthen the industry by helping consolidate the U.S. lead in low-volume, high-performance products. This approach would also make sense militarily since weapons and other DOD applications generally require custom designs produced in low volumes.

By supporting Sematech in what could be a futile race against Japan, DOD may repeat earlier government mistakes in protecting declining domestic industries. For example, in recent years the United States has negotiated voluntary restraint agreements (VRAs) that are intended to give the U.S. automotive and steel industries a chance to adjust to increased foreign competition. A VRA imposes import quotas or increases tariffs on foreign goods.

In both autos and steel, government protection did little to reverse the drop in U.S. market share. For example, automobile imports dropped to as low as 23 percent of the U.S. market at the height of the VRA in 1984, but have since rebounded to 29 percent. The failure of the auto VRA rests with the auto companies. General Motors, for example, failed to use the four-year VRA to make its domestic automobile operation more competitive. Instead, GM invested in one Korean and two Japanese auto firms, abandoned plans to develop its own small car, formed a joint venture with Toyota, and purchased Hughes Aircraft and Electronic Data Systems. In other words, GM diversified out of the auto industry. According to an International Monetary Fund report, the automobile VRA cost U.S. consumers nearly $18 billion in higher prices.

At least the five-year 1984 Steel Import Stabilization Act is an improvement over the auto VRA in that it requires the president to affirm annually that the industry is taking measures to improve its competitiveness. But despite restructuring, shipments of the two most important commodities—carbon and specialty steel—have declined, as have profits and employment. Now industry representatives are considering asking for further protection. In any case, a requirement to show that positive measures are being taken might not be workable in the case of Sematech. Given the inherently speculative nature of R&D, Sematech would be much less able to guarantee any breakthroughs.

Another undesirable effect of a VRA's unconditional protection is that it encourages the competition to manufacture products that are more advanced and more lucrative. When quantitative limits were placed on car imports, Japanese companies began to fill their quota with larger, more expensive vehicles that provided a greater profit per sale, thus maintaining overall profits.

In that respect, last year's semiconductor pact may

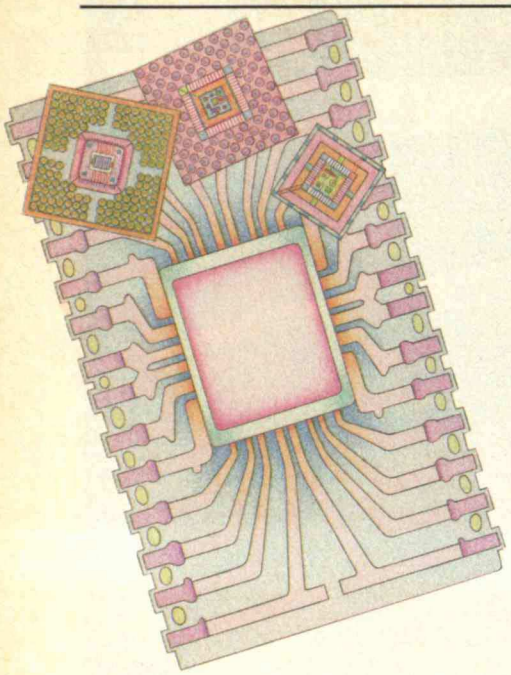
be stimulating Japanese firms to switch to more advanced and lucrative products. For example, Japanese companies could be strengthening their efforts to master gallium-arsenide semiconductor technology, expected to play a major role in opto-electronics for compact disks and in high-speed computer circuits. Gallium-arsenide semiconductors are faster than silicon semiconductors and more tolerant of radiation and high temperatures. In the United States, primary funding for this research comes from the Defense Advanced Research Projects Agency, thus limiting the potential for civilian applications.

In any case, gallium-arsenide chips are significantly more expensive to produce than typical silicon circuits, so their use in semiconductors may be limited to the military. The 64-megabit DRAM technology proposed for Sematech may have more immediate civilian applications in computers, communications, and consumer products. If DOD does participate in the consortium, it should be with the understanding that technology developed must flow freely back into the commercial mainstream.

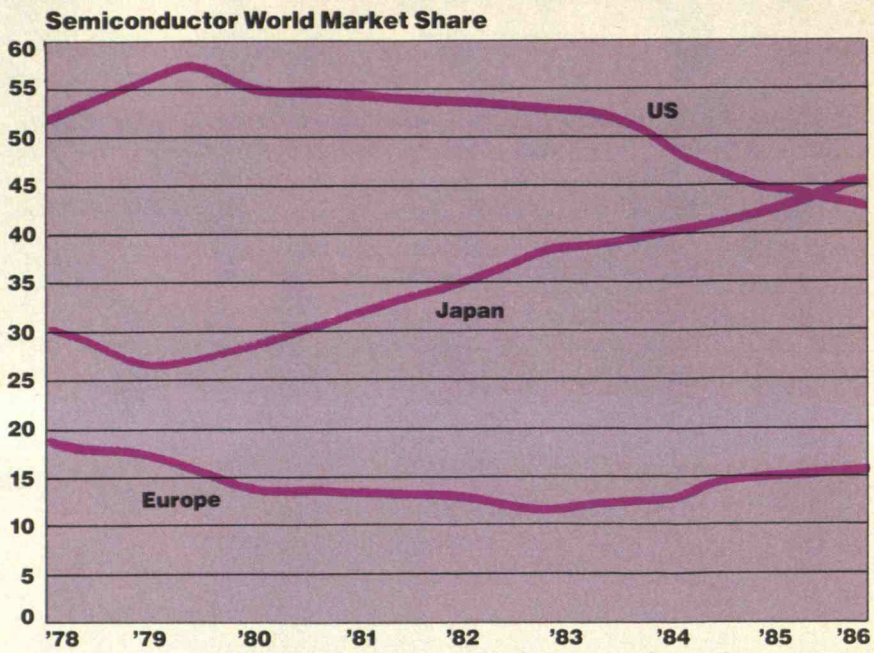
However, past DOD experience with semiconductor production suggests that such a flow of research into civilian applications is unlikely. For example, since 1979 DOD has administered the very high speed integrated circuits (VHSIC) program to develop radiation-resistant microelectronics technology and production capabilities. Commercial use of VHSIC technology is prohibited.

The VHSIC project's track record may also indicate Sematech's future under DOD guidance. While a 1986 report by the Office of Technology Assessment (OTA) found that many of the technological objectives of the program had been met, establishing pilot production lines took longer than anticipated. Low initial yields of usable chips and unrealistic technological goals led to delays of up to a year. Similarly, subtle process flaws can be expected if manufacturers seek to apply to high-volume production the medium-volume techniques Sematech would develop.

The VHSIC project illustrates another problem common to many military projects: cost overruns. Either Sematech or an independent DOD venture could easily metamorphose into yet another captive



U.S. manufacturers have seen their own share of the world semiconductor market shrink while those of Japan and Europe have grown.



defense industry with a voracious appetite for increasing appropriations. The VHSIC program originally was planned to cost $200 million over 10 years, the amount the DSB task force suggests investing in Sematech in the first year. According to OTA, the VHSIC budget has expanded to approximately $1 billion in order to incorporate the technology into military systems.

Even the SIA has suggested that DOD could get better semiconductors at lower prices if it set standards the way commercial buyers do rather than relying on special, narrowly defined military sources. Because of the multitude of contract specifications, many smaller companies simply see military work as unprofitable. Should DOD become more deeply involved with semiconductor production, it must clearly specify objectives for performance and realistic cost estimates.

As the task force suggests, stockpiling foreign-made semiconductors may be one feasible answer to the unlikely threat of interrupted supplies. Should the use of foreign military components or demand for foreign goods seem to present a legitimate cause for worry, domestic manufacturers could be designated as back-up suppliers in case of a national emergency or mobilization.

Moreover, although buying from U.S. sources has its attractions, DOD must seek superior technology wherever it lies. This is especially true since, given the steel and automobile experience, there are no guarantees that domestic companies with a protected market will upgrade their technology. If U.S. semiconductor producers are to remain competitive in bidding for military contracts, it will not be by accusing the Japanese of unfair practices.

Multinational Manufacturers

Even if Sematech or a similar project could save the U.S. semiconductor industry, national security is hardly the reason to take such action. The growing internationalization of the semiconductor industry makes the country of origin relatively unimportant.

While appealing to Washington for help, the industry has also been pursuing alliances with its rivals overseas, simply out of good business sense. For example, Motorola and Toshiba have a joint venture based on the former's lead in microprocessor technology and the latter's lead in memory chips. National Semiconductor designs, makes, and sells semiconductors in Japan with NMB Semiconductor; Honeywell, Compagnie des Machines Bull of France, and NEC cooperate on supercomputers; and Advanced MicroDevices has a marketing and technology agreement covering Sony digital chips as well as a sourcing agreement with West Germany's Siemens Corp.

Furthermore, the semiconductor pact has reinforced the need for both U.S. and Japanese companies to have plants in each other's country. With plants in the United States, the Japanese get tariff-free sales of their U.S.-produced semiconductors. With joint ventures in Japan, U.S. producers get access to Japanese manufacturing technology.

The Japanese government is unlikely to disturb these international arrangements and interrupt the

ILLUSTRATION: DAN COLLINS

Using new technologies, an advanced solid-state laser prototype has been produced that is more efficient and more readily scaled from low to high power than currently available models. The Hughes Aircraft Company-built prototype uses optical phase conjugation, ensuring that all light waves emitted are in phase, compensating for aberrations and distortions in a laser beam. Also, the new laser material used, co-doped gadolinium scandium gallium garnet, approximately doubles the efficiency and energy storage capacity of the laser. A follow-on contract has been awarded to Hughes for the second and third stages of the U.S. Air Force's Medium Energy Source (MES) program. Future applications of the new laser include communications, range finding, and target designation.

The United Kingdom Infrared Telescope (UKIRT) in Hawaii was the first to use a new infrared focal plane array, which has caused a technological revolution in infrared astronomy. The Hughes-built microchip "sandwich" provides sharp, fast infrared images of our solar system and the galaxies. Astronomers can now obtain a better look inside mysterious clouds of dust and gas, known as nebulae, to learn more about the life cycle of stars. The array also produces, for the first time, fine-grain infrared images of objects within nebulae that were previously hidden.

A processor utilizing advanced microchips will offer processing power equal to 200,000 desktop personal computers. This new programmable signal processor (PSP) uses very large scale integrated (VLSI) circuits called gate arrays to pack this power into a 65-pound box, which measures just one cubic foot in volume. By comparison, these 200,000 personal computers would weigh roughly 3.4 million pounds, without any add-on memory cards, disk drives, or monitors. If stacked 20 units high, the 200,000 personal computers would fill a room approximately 144 x 120 feet. The PSP is being built by Hughes for the APG-70 radar system to be used aboard the U.S. Air Force F-15.

The nation's newest weather satellite has completed the U.S. weather-watch system. The Geostationary Operational Environmental Satellite (GOES) H, launched into orbit over the Atlantic seaboard, provides data for meteorologists to predict and monitor storm fronts threatening the East coast. Designed and built by Hughes for the National Oceanographic and Atmospheric Administration, GOES H carries two experimental payloads: a space-environment monitor (SEM) for solar-wind measurements, and a receiver designed to aid international search and rescue missions.

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shipment of crucial components. Japan has a constitutional limit on military spending and relies heavily on the United States for its security. Consequently, it is in Japan's interest to supply extremely reliable high-tech components to the U.S. arsenal.

If Japan did decide to withhold its most advanced technology, it would have learned that lesson at the knee of U.S. companies. The reluctance of U.S. companies to license technology to foreign firms has stimulated the latter to redevelop certain technology on their own. A good example is the 32-bit microprocessor for small computers and robotics. Currently, three U.S. companies—Motorola, Intel, and National Semiconductor—control 97 percent of the world market of 32-bit microprocessors. Now Japan is developing a new standard operating system for microprocessors that directly threatens the U.S. dominance. Fujitsu and Hitachi are engaged in a joint venture to develop the 32-bit microprocessor, while the University of Tokyo will pursue an industry-backed project to develop an operating system.

The question is whether the Defense Department alone should respond to slumping semiconductor demand.

Facing the Long Term

Now Sematech has begun to wend its way through the congressional budget process. This spring the Senate Armed Services Committee recommended funding the consortium at $100 million annually for two years, with an additional $100 million for only one year to improve DOD's chip-manufacturing capability. The full Senate has not yet voted on the bill. The House recommended a one-year, $10 million grant. After the Senate vote, the bill would go to conference. However, many of the chipmakers solicited to fund Sematech are delaying any firm commitment until Congress makes its decision. Their reluctance, which could cool congressional interest in the venture, can only serve as a warning that Sematech is replete with risk.

There may be cheaper, more efficient ways to stimulate civilian R&D than the Sematech consortium. Ultimately, the question is whether DOD alone should respond to a slump in demand for semiconductors. As the DSB report points out, "DOD has no inherent responsibility for the commercial viability of the U.S. semiconductor industry."

If the real goal is to make the U.S. semiconductor industry competitive again, government and industry must first accept the internationalization of high technology as a given. Industry should stop trying to have it both ways—to have Japanese investment *and* the right to complain about it.

More important, rather than relying on a series of ad hoc handouts, government and industry must begin a coherent effort to develop an integrated national-security strategy that will address structural problems over the long term. Both must recognize that the chip industry is inherently cyclical, with booms and busts that outpace government attempts to reorder the situation. Indeed, just as Congress is deciding the fate of Sematech funding, the chip sector is showing signs of pulling out of its latest slump. The U.S. industry is slowly restructuring and consolidating to become more competitive and more vertically integrated like its overseas rivals.

No doubt the government has a stake in the health of the U.S. electronics industry. By the year 2000, this semiconductor-dependent sector of the economy will account for 25 percent of the gross national product. Last year alone, Congress allocated approximately $400 million to support semiconductor R&D in DOD laboratories and agencies, by defense contractors, and through National Science Foundation grants for basic research in universities.

Yet problems in obtaining R&D funding at reasonable interest rates will never be solved until the monstrous federal deficit is reduced substantially. An additional long-term problem that must be faced is the dearth of technical education in the United States. The DSB report proposed the creation of eight centers of excellence at U.S. universities to support R&D in semiconductor science, but the effort must go beyond the high end of engineering and reach the labor force that must cope with increasingly technical manufacturing plants.

These long-term issues are not easy to solve, nor do they offer flashy political gratification in the short run. But they must be dealt with and dealt with soon. Otherwise, paraphrasing Samuel Johnson's observation that patriotism is the last refuge of a scoundrel, national security will become the last refuge of the protectionist. □

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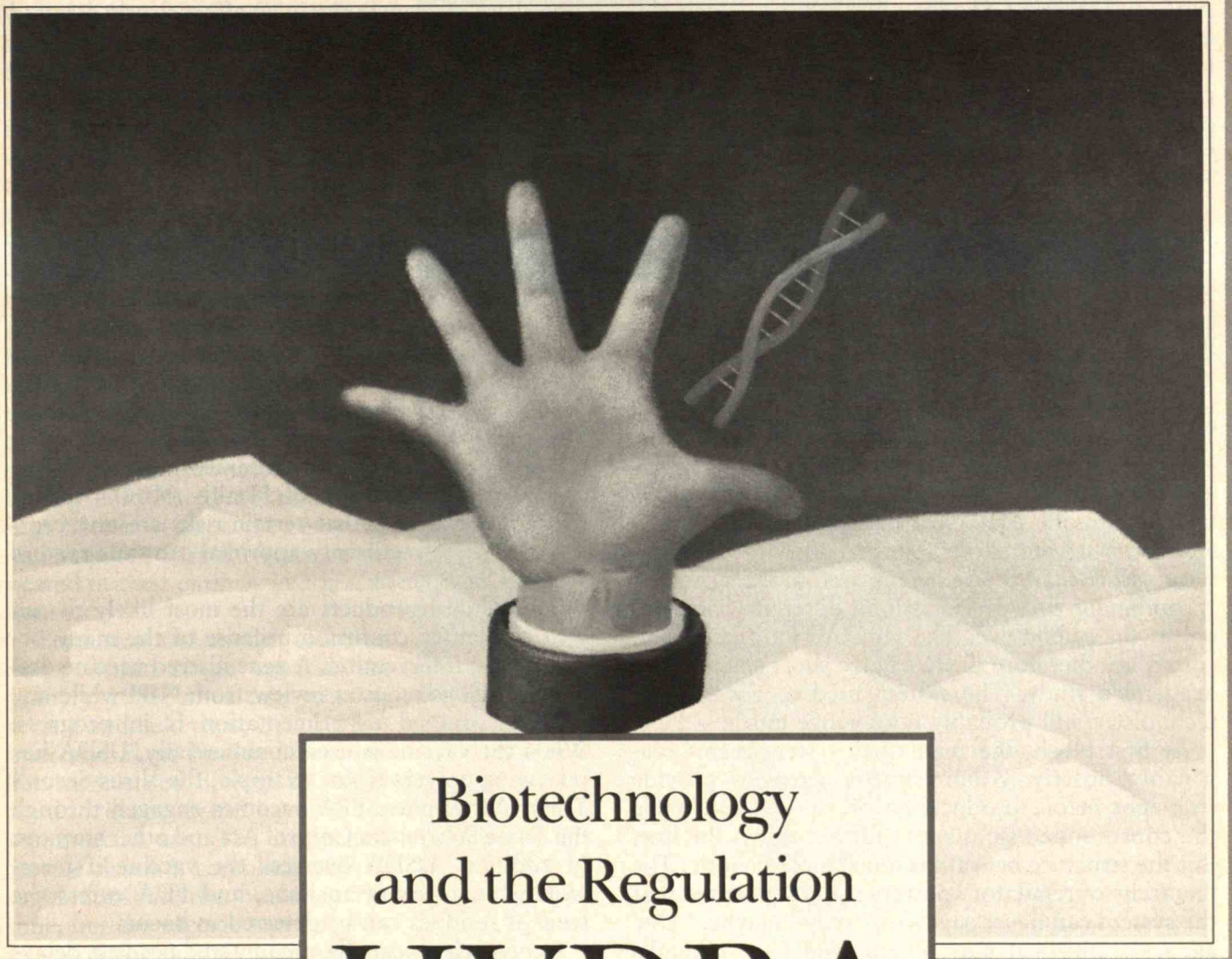
Disorder in the regulatory process threatens to undermine biotechnology in the United States.



Biotechnology and the Regulation HYDRA

BY PETER W. HUBER

You almost have to be a lawyer before you can be a scientist." So says Gary Strobel, professor of plant pathology at Montana State University. Last June, Strobel injected elm trees with bacteria whose natural

ILLUSTRATIONS: ROB COLVIN

Genentech reportedly encountered delays while USDA and FDA argued over who should regulate a product.

capacity to secrete a toxin active against Dutch elm disease had been enhanced through genetic engineering. He deliberately chose not to secure the required permission: he characterizes his act as civil disobedience, in protest of the number and complexity of regulations affecting genetic-engineering R&D.

While most biotechnologists have condemned what Strobel has done, many share at least some of his frustration. After all, conventional "genetic engineering"—such as animal husbandry and systematic crop breeding—faces few regulatory obstacles. But recombinant DNA technology is the target of abundant regulatory effort, even though its end products are often biologically indistinguishable from those developed by more traditional work.

A panel of the National Academy of Sciences recently concluded that genetically altered organisms pose no unique ecological hazards, and that regulation should be tailored to the nature of the organism rather than to the means used to create it. But recombinant DNA products look different from others in the public eye. The regulatory agencies and courts are therefore likely to give short shrift to the academy's study. The system used to govern biotechnology will probably not change much.

At first blush, the regulatory system seems reasonably orderly. Administrative agencies provide oversight before products go on the market, while the courts supervise matters farther down the line. But the structure beneath is much more chaotic. The hierarchy of regulatory powers is so fragmented that the system can never say "yes," only "maybe." One agency's approval may be trumped by a second's disapproval. Approvals by two agencies may be refuted shortly afterward by a federal court. And approvals by all three may be rejected by a liability court following an accident decades later.

Gary Strobel has made his point the wrong way, but he has a point nonetheless. The gravest regulatory threat to the development of biotechnology lies not in the stringency of regulation, but in its ponderous disorder. The economic stakes are high, and the U.S. lead is vulnerable. France has launched a major government program in the area. Japan's Ministry of Trade and Industry is working closely with that country's companies in an effort clearly directed at capturing world leadership. We need more expeditious, predictable, and coherent regulation if we are to preserve our head start in this critical new field.

Struggles among Agencies

The problems begin in the administrative agencies. Conflict among federal regulatory officials over biotechnology is notably common because many agencies may have jurisdiction over a genetically altered product. The federal agencies that can become involved include the Environmental Protection Agency (EPA), U.S. Department of Agriculture (USDA), Food and Drug Administration (FDA), Occupational Safety and Health Administration (OSHA), and National Institutes of Health (NIH). Any of them may conclude that certain risks are unacceptable. Effective regulatory approval can thus require a quiver of licenses.

Agricultural products are the most likely to run into regulatory confusion because of the many occasions for intervention. A gene-altered vaccine destined for hogs requires review from NIH while any federally funded experimentation is in progress. When the vaccine is used commercially, USDA has reviewing powers if, for example, the Virus-Serum-Toxin Act applies. EPA becomes engaged through the Toxic Substances Control Act and other statutes. In addition, OSHA oversees the vaccine if farmworker exposure is an issue, and FDA enters the scene if residues can be detected in bacon.

Genentech reportedly encountered needless delays and expenses while USDA and FDA argued for more than a year over which agency should regulate the company's new bovine interferon. The agencies were unable to decide whether the product was a "veterinary biologic" under USDA's jurisdiction or a "new animal drug" under FDA's control. Genentech finally licensed the product to Ciba-Geigy Corp. in 1985. (That company is now field-testing bovine interferon under FDA's jurisdiction, with the dispute resolved through an interagency memorandum.)

Another recent, much-publicized incident suggests how varying rules from different agencies may contribute to confusion. Advanced Genetic Sciences, Inc., had deleted genes from a common plant bacterium. The company wanted to test how well this altered organism, when sprayed on certain crops,

PETER W. HUBER, a lawyer and engineer, is a senior associate at Science Concepts, Inc., and a senior fellow of the Manhattan Institute, a law and public-policy think tank. His book on liability law will be published by Basic Books in 1988.

would reduce the risk of frost damage. Last year, as part of the many tests the government requires for a genetically engineered bacterium, scientists injected the organism into the bark of fruit and nut trees located on the rooftop of a company building in Oakland, Calif. The research apparently complied fully with NIH guidelines for a release into the environment—the first such rules written. But in this case EPA approval was required instead, and that agency's regulations concerning environmental release were more stringent. EPA decided that the rooftop testing constituted an unauthorized release. It fined the company and required that the tests be repeated in their entirety in a greenhouse.

Confusion and conflict can even occur within single agencies. In January 1986, after two years of review and field tests, USDA's Animal and Plant Health Inspection Service licensed Biologics Corp.'s pseudorabies swine vaccine for commercial use. The inspection service claims it complied with all regulations on the books at the time, but the vaccine was not processed through the department's Recombinant Advisory Committee. According to news reports, critics of the inspection service in USDA's Science and Education Division told the press that the vaccine had not received proper approval. A lawsuit was subsequently filed, and sometime this fall a federal district court in Washington, D.C., is expected to determine whether the inspection service violated any regulations. A ruling against the service will undoubtedly set the stage for lengthy appeals.

Agricultural products are not

At least two gene-altered vaccines synthesized in the United States have been taken abroad for testing under more hospitable oversight.

unique. A drug for human use may require approval from FDA because of the patients, NIH because of researchers, and OSHA because of production workers. An industrial process using gene-altered enzymes may invite EPA, OSHA, and FDA oversight.

Some semblance of order in the system started to emerge following the publication of a major study by the White House Office of Science and Technology Policy (OSTP) in June 1986. The report, entitled the "Coordinated Framework for the Regulation of Biotechnology," summarizes relevant federal laws and policies and concludes that no new legislation is needed. It urges that agencies adopt scientifically consistent definitions and standards, and that a single agency exercise responsibility over a given product whenever possible. For cases in which more than one agency has statutory authority, the report establishes a lead agency and provides for coordinated regulatory review. At least one interagency group, the Biotechnology Science Coordinating Committee, has formed as a result of OSTP's work. This group has worked on defining terms that heretofore have had different meanings for various agencies, such as "release into the environment."

The OSTP initiative and the interagency coordination that has started to take shape are commendable. But the record of agency conflicts, and the confusion that they have created in the industry, are not encouraging. As the number of biotechnology products increases, interagency conflict will likely recur.

Federal/Local Overlaps

Relations among federal, state, and local governments raise more delicate questions regarding jurisdictional turf and bureaucratic sensibilities. One early local initiative was a three-week moratorium by Cambridge, Mass., on recombinant DNA research at M.I.T. and Harvard. Later, in 1976, the city council passed an ordinance making NIH guidelines for government-sponsored research applicable to any projects conducted in the city. The ordinance also imposed additional safety requirements and banned deliberate releases of living, gene-altered products and so-called "biosafety level 4" or "BL4" experiments, which NIH considers to involve especially dangerous or contagious organisms.

Local initiatives of this type undoubtedly have an impact. For example, Advanced Genetic Sciences originally wanted to test its frost-suppressant bacteria in Monterey, Calif., but county officials blocked the experiments. Then, after the company received the go-ahead from two other California counties, the EPA-approved tests were performed under laughably excessive regulation. The scientists who sprayed the wholly innocuous bacteria were required by the California Department of Food and Agriculture to wear suits seemingly appropriate for a moon-walk: fully sealed and complete with helmet, gloves, and breathing pack. Both state and federal regulators also required a barrier around the test site to prevent inadvertent or deliberate trespass.

Monsanto encountered comparable problems with local regulation after it isolated a gene that holds great promise for controlling the black cutworm, a serious corn pest. The company inserted the gene into a microbe so that a protein lethal to this parasite could be created. The county in which the first tests of the resulting microbial pesticide were to be conducted supported Monsanto, but city officials in nearby St. Charles, Mo., passed a resolution opposing the company's efforts. The resolution was purely advisory since the tests were to be conducted outside town lines, but EPA has delayed approval nonetheless.

It's interesting to note that Monsanto meanwhile inserted the same gene into a tomato plant to make it resistant to certain parasites, then secured USDA approval for experiments on this crop. The tomato field tests were conducted across the state line in Illinois, where rural communities proved accommodating.

State regulatory initiatives are evolving, too. New Jersey, for example, is considering legislation to establish a Commission on the Release of Genetically Engineered Microorganisms. That organization would not only monitor compliance with federal regulations but review the adequacy of existing state laws. California has considered several regulatory bills of different severity, but so far the state legislature and a special task force have concluded that the existing matrix of environmental regulation suffices. Other states have also considered initiatives.

The international reach of U.S. safety and environmental standards is yet another troublesome issue. At least two gene-altered vaccines synthesized in the United States have been deliberately taken abroad for testing under more hospitable regulatory oversight. The Wistar Institute, a Philadelphia

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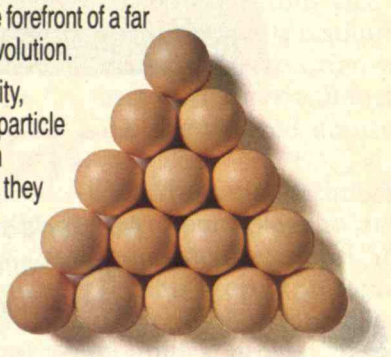

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ALCOA

Even wholly unsuccessful lawsuits can sink a valuable product.

biomedical institution that has long pioneered vaccine development, performed early tests of a new bovine rabies vaccine in Argentina. And researchers at Oregon State University went to New Zealand to conduct field trials of a vaccine against the insect-borne Sindbis virus, which plagues animals. NIH is investigating whether these offshore tests have violated federal rules. A finding that they have could convince American companies to conduct joint ventures with concerns based elsewhere. Some biotechnology companies are already talking about collaborating with Japanese firms, so that tests can be conducted abroad without U.S. government oversight.

The Courts as Gatekeepers

Relations between the federal agencies and the courts regarding biotechnology are at least equally confused. The National Environmental Policy Act (NEPA), passed in 1969, empowers courts to review agency actions that will have a "significant impact" on the environment. The act also requires agencies to prepare an environmental impact statement in connection with such projects. NEPA's reach extends to agency approval of private ventures as well as federally funded projects. The phrasing of NEPA is sufficiently hazy to permit courts that oversee it to act as full-fledged gatekeepers in the approval process.

The courts have already done so on several occasions. In May 1984, Judge John Sirica of the Washington, D.C., federal district court invoked NEPA to block the NIH-approved test that researchers at the University of California wanted to conduct on a frost-inhibiting bacterium similar to the one developed by Advanced Genetic Sciences. NIH had not filed an environmental impact statement for the test. Genetic-engineering opponents are also trying to use NEPA to halt University of Pennsylvania experiments in which genes that produce human growth hormone have been transferred into mouse, pig, and sheep cells. Several NEPA suits have been filed by one organization critical of genetic engineering, the Foundation on Economic Trends. We can expect NEPA litigation to burgeon.

The nuclear power industry knows this situation well. That business has had particularly vivid experiences with the game of "NEPA-go-seek," in which a reviewing court repeatedly finds something wrong with an agency's environmental impact analysis and sends officials off to investigate another detail. After the Natural Resources Defense Council sued the Nuclear Regulatory Commission (NRC) over rules it developed for nuclear waste disposal, the circuit court of appeals in Washington, D.C., struck down the regulations. NRC took the case to the Supreme Court, which reversed the decision and remanded the case to the circuit court for further consideration of certain issues. The court struck down the rules again, this time on different grounds, and in an appeal the Supreme Court reversed the decision again. The process took about a decade.

Judicial second-guessing of administrative licensing decisions can also come through the tort system, which addresses one category of civil wrongs. This part of the regulatory picture is less clear because of the dearth of significant accidents with genetically altered products. But recent experience with pharmaceuticals and herbicides suggests that even if the companies or individuals releasing these materials are not negligent, they will be held liable for all damages that juries may conclude were caused by exposure.

Tort law expressly accepts that the agencies and the courts may send very different regulatory messages. The 1964 Second Restatement of Torts, assembled by a distinguished panel of lawyers on behalf of the American Law Institute to summarize liability law, flatly declares that "compliance with legislative enactment or an administrative regulation does not prevent a finding of negligence." In 1984, for example, the Karen Silkwood lawsuit established that complete compliance with NRC safety standards does not protect a nuclear operator from an award of punitive damages in a state court. Thus, a jury may decide that conduct deemed fully prudent by federal regulatory standards is in fact "outrageously careless." And a judge or jury can then assess an unlimited fine against the responsible party. Biotechnology entrepreneurs must recognize that under current law, complete compliance with all federal and state regulatory requirements will afford no liability protection in the event of an accident.

More troubling is the implicit idea that any accident—even if it does not harm people or property—is probably serious enough to deserve monetary compensation. Following the incident at Three Mile Island, for example, the utility paid millions of dollars to settle personal-injury and prop-

Complete compliance with biotech regulations will afford no liability protection.

erty-damage lawsuits out of court. All subsequent scientifically reputable studies by the Commonwealth of Pennsylvania and others have concluded that the accident had no measurable impact on the physical health of nearby residents.

Even wholly unsuccessful suits can sink a valuable product if brought in sufficient number. In 1983 a cascade of costly litigation drove the drug Bendectin, prescribed for morning sickness, off the market. On the basis of more than 20 epidemiological studies, FDA believed Bendectin was safe. While a handful of juries voiced their disagreement through verdicts requiring multi-million dollar payments, the vast majority of judges and juries reached the same conclusion as FDA. Merrell Dow Pharmaceuticals, Inc., the drug's manufacturer, found that even if it won suits, it spent much more defending and insuring itself than it earned in profits from sales.

Erratic Regulation: Drag on Development

One obvious problem with our multi-layered system of regulation is that all phases of the process are painfully slow. Delays running into months and years are now routine. And the liability system as it currently operates guarantees that the regulatory process is never really concluded. Judgments on a product's acceptability often come only decades after the original research, development, and commercialization. A firm that embarks on a venture to bring new biotechnology products to the mass market is betting its future on this unpredictable system.

A second problem concerns the expense and competitive disadvantage of having to hurdle high regulatory barriers very early in a product's lifecycle. A company seeking to develop a genetically altered pesticide, for example, must invest large sums at the very beginning to satisfy agency requirements. But the same manufacturer can test hundreds of conventional chemical alternatives and select only the most promising before having to do battle with local and Washington officials.

Most worrisome is the fact that the uncertainty permeating the regulatory system can be exploited by those seeking to retard biotechnology. Emphasizing the unknown potential for risks, and taking advantage of the system's divisions, these people achieve their greatest successes when decision-makers in the courts and in several state and federal agencies collide.

Biotechnologists thus face uncertainty in both the scientific and regulatory domains. A company cannot be sure that a product it is trying to make will work. Nor can it be sure that regulators will approve the product. And the firm has no idea of the ultimate cost to defend itself in lawsuits that may materialize later, whether or not they are justified. While uncertainty on the scientific side creates both problems and opportunities, uncertainty in the regulatory system offers only negative returns.

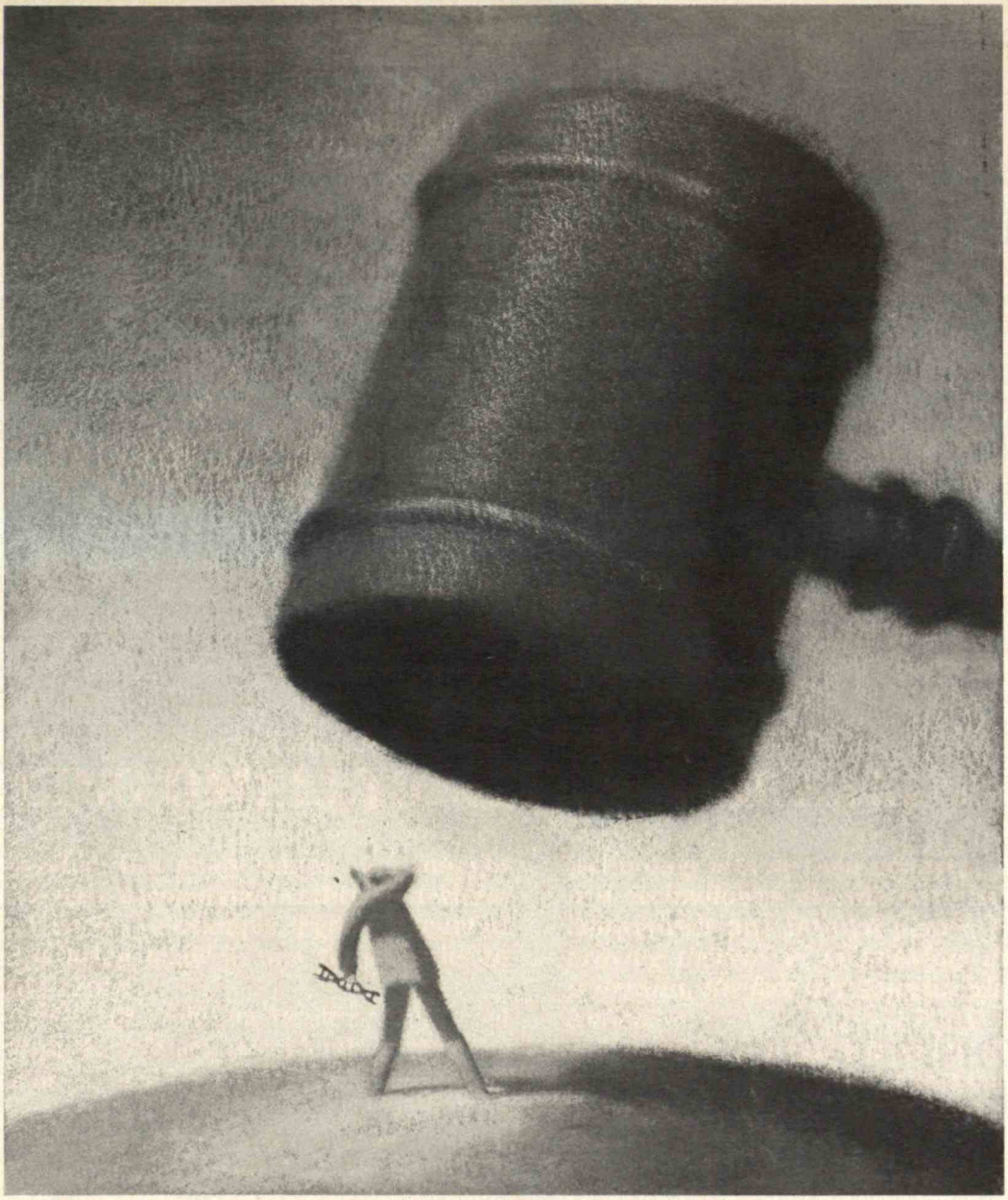
When Genentech, for example, undertook research on tissue plasmogen activator (TPA), which dissolves blood clots following heart attacks, the company knew little about how effective the drug would prove, or how feasible or costly it would be to develop. But there was also the possibility for enormous profit if all worked well. TPA could be one of the first high-revenue products of biotechnology, with several million dollars in sales a year. But last May Genentech suffered a major setback when an FDA advisory committee concluded it had insufficient data to support TPA approval. Although the drug will almost certainly be approved eventually, it is now undergoing more studies at further cost to the company.

Any endeavor can tolerate only so much uncertainty. Compounding scientific doubt with unnecessary layers of regulatory unknowns will sink many undertakings regardless of their scientific and economic merits.

Pressing for More Collaboration

A strong biotechnology industry ultimately depends on a regulatory system capable of making expeditious and definitive judgments. We would do best to switch from local control to national regulatory oversight, because both the benefits and risks of biotechnology transcend state boundaries. Genetically engineered products can hardly be successfully commercialized in the United States if their development can be stopped at the penultimate moment by shifting, non-uniform demands. Administrative power over any particular biotech venture should be firmly lodged in a single, identifiable agency—and in just one division of that agency.

Sweeping new federal legislation to consolidate regulatory authority is possible. But the idea will seem most attractive to those least familiar with the Washington political process. A bill that is well-



crafted and clean when it is drafted rarely emerges from Congress in the same condition. A new statute designed to streamline could easily end up adding one more layer of decision-making authority to the system. For the time being, the best political bet is to stick with the laws on the books while pressing for less local government involvement and more of the interagency collaboration the OSTP report calls for.

It is difficult to specify the means by which the courts that review agency actions through NEPA should hold their authority in check. Clearly they have an important responsibility to describe finite, comprehensible requirements that reasonably conscientious agencies can satisfy. In the end, reviewing judges will have to do what is often hardest for them: resist the temptation to engage in endless fine-tuning.

The potential liability problems, though the least apparent and immediate today, remain the most intractable. Perhaps the best prescription one can realistically suggest is that the courts should give greater deference to decisions by administrative agencies. An agency's full, unqualified approval of a test or commercial operation should be viewed for what it is—considerably more than a routine pleasantry that may be dismissed as soon as a tort plaintiff enters the courthouse. Complete, good-faith compliance with applicable safety regulations must provide some safe harbor.

No regulatory system will ever be "right" about every issue clouded in scientific doubt. But an industry should be able to ask for a process that will be reasonably quick and definitive. Regulatory judgments should not be subject to revision every time the locus of authority shifts among federal and local agencies and the courts. □

CONTINUED FROM PAGE 45

oil and hence pollution.

Several less expensive policies also could decrease our vulnerability to oil crises:

☐ Deregulating natural gas and electricity markets is making production and distribution of these energy sources more efficient. In the long run this could lower their costs, increase their share of total energy use, and reduce U.S. reliance on imported oil.

☐ Revising or abolishing the windfall-profit tax would encourage oil exploration by increasing the financial rewards for it. This tax was enacted to prevent companies from making "excessive" profits from external factors such as OPEC's price increases. However, oil prices are fluctuating wildly. Oil companies suffer when prices drop and do not make as much as they normally would when prices rise. Producers of other commodities do not face similar taxes.

☐ Providing loan guarantees and technical assistance to increase energy production around the world would heighten energy security. It would lower the world's reliance on OPEC oil, making a potential oil crisis less likely and less severe. However, since nearly all energy production is profitable, subsidies are not warranted.

☐ Allocating petroleum products to ensure "equitable" distribution of the shortages should be avoided. The Nixon administration began this practice, and the Carter administration showed how unworkable it can be. A handful of government employees proved unable to distribute oil as efficiently as tens of thousands of oil-company employees. For example, Carter officials sent gasoline to vacation spots in 1979 while people stayed home because of the shortage. Farmers were allowed to fill their tanks with diesel fuel, while truckers could not get the fuel they needed to move farm produce to market. Also, politics often influenced the allocation of supplies. Motorboat owners were given the same access to "emergency" oil supplies as hospitals because of their powerful lobbying in Washington.

If the United States and the other developed nations take the proper preventive measures now, then after the next energy crisis, we will be able to congratulate ourselves on our foresight instead of analyzing our mistakes. ☐

MAKING OMELETS WITHOUT BREAKING EGGS

It's impossible. But many things once thought impossible have become routine through technological advance. For example, a great amount of progress is being made in new technologies to burn coal cleanly.

Since 1973, air pollution resulting from coal combustion has fallen considerably, even as America has turned increasingly to coal for electric power and other important energy needs. However, existing clean coal technologies—stack gas scrubbing and coal washing—are limited in their ability to meet future clean air requirements, because of cost and applicability. *Emerging new coal-use techniques will expand the number of options available to coal users—current and future.*

Clean coal technology is hundreds of advances in science and engineering along with the creativity to put them together into workable, affordable systems. Clean coal technology will allow America to use more coal in the future. Cleanly and economically.

Today, there are advanced coal utilization schemes of several kinds. Some will allow older coal-fired boilers to be rebuilt as cleaner, more efficient units. Other advances apply to coal-fired units that will be built in the future. Clean coal technology is more than a concept. Most of these new technologies already have been proved in laboratories and in pilot plants. *Now they are proving themselves in full-scale demonstration programs, the last step toward full commercialization.*

Commercial demonstration projects are moving at an exciting pace. American industry is investing large sums of money. In many cases, state and federal funds supplement this effort. Not all clean coal projects will succeed. But many will. And these will form the basis for our next generation of coal-fired power plants and industrial boilers, both new units and rebuilt older ones.

This investment of money and time is a sound one. The payoff in future environmental quality and economic vitality is great. Consolidation Coal is very proud of its involvement in these coal use technologies for the future. To learn more about this subject, write for our free booklet, "A Clean Coal Technology Primer." It won't help you make omelets, but it will tell you about some new ideas that are being hatched.

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Pittsburgh, Pennsylvania 15241

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borne ballistic missiles are completely computer controlled, both before launch and in flight.

Finally, many nuclear power plants outside the United States are computer controlled and monitored, though the two functions rely on different sets of software and hardware. A few in the United States have either digital controls or digital monitors (I know of none that has both). The Three Mile Island and Chernobyl plants both lacked intelligent digital monitors, and indeed, such technology might have prevented the accidents at those sites.

Digital computers are no worse, probably better, than analog or manual controls since there is less hardware subject to random failures. The software, once properly designed and tested, never fails. The real issue is to design the software to be testable and to have an adequate budget for testing.

MYRON KAYTON
Santa Monica, Calif.

The author responds:
Kayton is correct that life-critical computer systems are being used daily by large numbers of people, and that they are often more trustworthy than the mechanical or human-control systems they have replaced. However, such systems, many of which are small and well-understood and have been incrementally refined, are different from large software systems with a high level of technological innovation.

Kayton refers to the Concorde aircraft having a control element equivalent to a 4,000-word digital computer. That is roughly four orders of magnitude smaller than the estimated size of the command and control software proposed for SDI.

He also implies that I should have argued for larger budgets for testing safety systems. I intended to do this when I recommended we insist on using the best existing techniques for developing dependable software.

My overriding purpose was to emphasize that we cannot eliminate the possibility of failure, even in the most reliable systems. Although the consequences of an aircraft failure may be unbearable for those immediately affected by it, they are not necessarily unbearable for society as a whole. I am most concerned about computer systems for which absolutely no risk of failure is acceptable. SDI requires such a system, and I am not certain it could be devised.

INDUSTRIAL MYTHOLOGY
Though I agree with the basic conclusions of Stephen S. Cohen and John Zysman in "The Myth of a Post-Industrial Economy" (*February/March 1987, page 54*), I think they are trying to jump on the policy train before they have diagnosed the condition of the underlying roadbed. Perhaps they are correct that the concept of the post-industrial economy has taken on the character of myth. Yet it helps no one to recommend a return to another, truly traditional myth—the view that services are simply ancillary to manufacturing. The argument would be stronger if the authors recognized the symbiotic relationship between services and manufacturing that has come to characterize the economy.

PETER BEARSE
Trenton, N.J.

SMOKESTACK SUCCESSES
I agree with all the recommendations Charles F. Sabel, Gary Herrigel, Richard Kazis, and Richard Deeg make in "How to Keep Mature Industries Innovative" (*April 1987, page 26*). But I don't think the point has been proven that the decline of mature American industries is due solely to their success in applying traditional ideas about specialization and production efficiency. Many smokestack companies have remained successful despite adhering to these methods. The authors also ignore the diversified businesses of high return that attracted managements during the period they discuss.

Moreover, there is an important difference between the machine-tool and textile-machine industries. Through 1986, most American companies were willing to pay 15 to 20 percent more for American textile machines than for foreign-made equivalents because of special tooling, better service, and loyalty. In contrast, many American machine-tool companies sold their products at a substantial loss between 1982 and 1985, and some have already gone out of business because of this.

ARNOLD O. PUTNAM
Lexington, Mass.

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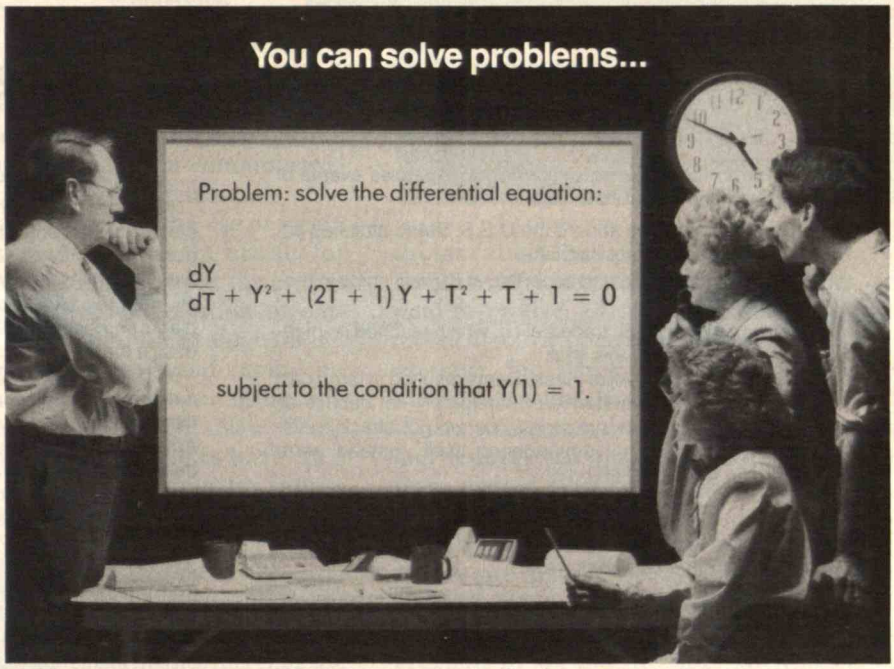

Symbolically...

```
(C1) DEPENDS(Y,T)$
(C2) DIFF(Y,T)+Y^2+(2*T+1)*Y+T^2+T+1;
```

$$(D2) \quad \frac{dY}{dT} + Y^2 + (2T + 1)Y + T^2 + T + 1$$

```
(C3) SOLN:ODE(D2,Y,T);
```

$$(D3) \quad Y = -\frac{\%C\,T\,\%E^T - T - 1}{\%C\,\%E^T - 1}$$

```
(C4) SOLVE(SUBST([Y=1,T=1],D3),%C),NUMER;
(D4)    [%C = 0.5518192]
(C5) SPECIFIC_SOLN:SUBST(D4,SOLN);
```

$$(D5) \quad Y = -\frac{0.5518192\,T\,\%E^T - T - 1}{0.5518192\,\%E^T - 1}$$

and Numerically.

```
(C6) FORTRAN(D5)$
      Y = -(0.5518192*T*EXP(T)-T-1)
     1    /(0.5518192*EXP(T)-1)
```

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A view from Washington

THE STORY BEHIND RECENT HEADLINES

What do the following major front-page news events of the past year have in common?

- The loss of 31 lives aboard the U.S.S. Stark, attacked accidentally by an Iraqi warplane.
- The U.S. reflagging and escorting of Kuwaiti ships in the Persian Gulf.
- The staggering U.S. trade deficit, which reached its highest point in history this year.

The answer is oil. All of these events resulted in large part from our heavy dependence on foreign oil. Yet despite all the attention to these symptoms, we are not attacking the disease of foreign oil dependence itself. Instead we're becoming more hooked on it.

The Problem With Oil

The major oil problem is that most of the world's supply belongs to other countries.

- Almost two-thirds of the world's proven oil reserves lie under the nations of the Persian Gulf.
- The U.S. controls only about 4.6 percent of the world's oil reserves, but we still use more than 25 percent of the world's annual production.
- From 1976 to 1986, we paid $640 billion for foreign oil, or about one-fourth the cost of all our imports.
- Last year the U.S. imported 6 million barrels of oil per day, an increase of more than 1 million barrels per day over 1985.

The Electric Solution

The solution to our growing oil addiction is the same as it was after the 1973/74 Arab oil embargo – to use energy more efficiently and to turn to more electricity generated by our own abundant sources.

Since the embargo, electricity has helped us cut the use of foreign oil and, at the same time, has fueled our economic recovery and growth. Heavy industries, businesses, and even homes are turning away from burning oil to increased reliance on electric systems.

Society is in a transition from an age dominated by oil to an age of electricity. In 1986 we used almost 40 percent more electricity than we did in 1973. This past summer, utilities across the country reported record electric usage they had not expected for years to come. Those new supplies of electricity have come almost entirely from coal and nuclear energy.

The Role of Nuclear Energy

Nuclear energy is now the second largest source of our electricity after coal. In just 30 years, more than 100 nuclear power plants have been licensed to operate in 32 states. As these plants were switched on, older plants, mainly using oil, were set aside for backup service. In 1986, our nuclear plants produced the electricity equivalent of 2 million barrels of oil a day.

With 13 plants still being built, nuclear energy will be the nation's fastest growing source of electricity for the rest of this decade. And public attitude research indicates the American public is counting on nuclear energy – 80 percent believe nuclear energy will be important in meeting our electricity needs in the years ahead, and 77 percent believe our need for nuclear energy will grow.

But nuclear energy's future growth is in doubt. Financial, political and regulatory uncertainties are preventing utilities from planning any new baseload power plants. At its current growth rate, electricity demand will overtake our reliable supplies in the early 1990s. So we should be planning new electric plants now. But with very few exceptions, we are not.

What will happen? First, we will be forced to switch back on the old oil-fired plants which our coal and nuclear electric generation had pushed into standby service. Then, utilities will order and build the plants that can be put up fastest and cheapest – which means even greater use of oil and more expensive electricity because of high fuel costs.

As a result, we are headed toward greater dependence on foreign oil during the time when international tensions over oil are higher than ever.

Coal and nuclear energy baseload power plants, by themselves, may not solve the tensions in the Mideast and other oil-related problems. But they helped us and the rest of the world overcome the energy crises of the 1970s, and they can help prevent even more economic and also military crises in the 1990s and beyond – crises that will inevitably occur if the world continues competing for Persian Gulf oil instead of turning to the alternatives that are at hand. The result could mean a Persian Gulf stranglehold on U.S. economic strength and on our security.

Harold B. Finger
President and Chief Executive Officer
U.S. Council For Energy Awareness

A View From Washington is a series of essays sponsored by corporations and associations. The views expressed do not necessarily reflect those of the magazine.

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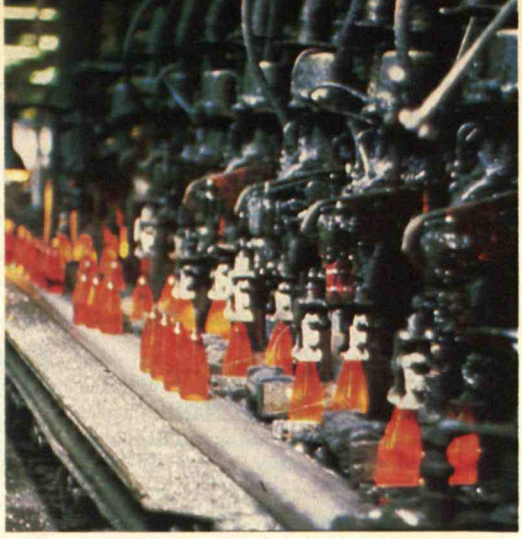


Melting ground glass instead of using raw materials to make new products saves energy and lowers furnace emissions.

expand if you can assure manufacturers of a large, constant supply of high-quality materials. In cases where secondary materials compete directly with their virgin counterparts, the steady supply of a non-contaminated product will create its own demand."

Government subsidies on the use of virgin resources have often undercut the market for secondary materials. For example, tax credits generally have favored exploitation of natural resources like timber, sand, and bauxite. Tax breaks on freight costs and capital investments rewarded industry for using raw rather than recycled materials. New York, North Carolina, and other states have tried to remedy this situation by giving tax breaks to companies that use secondary materials or purchase recycling equipment. Florida and Wisconsin also offer sales-tax exemptions for firms that use recycled materials. Other states are considering ways to reduce the amount of garbage they produce—by curtailing the amount of packaging on products sold or manufactured within their borders, for example.

Crushed glass, called cullet, and flattened cans await transport to manufacturers. Cullet can replace some or all of the sand, soda ash, and limestone a mill uses to make a glass.

Some states are spurring demand for secondary materials by increasing their use by the public sector. New Jersey's recent solid-waste bill requires state agencies to use recycled paper "whenever the price is competitive." Maryland government buys half its bond paper and nearly all its tissues and towels from manufacturers that use recycled materials. Similar actions by the federal government influenced napkin producers to use waste paper. The voluminous *Federal Register* is also printed on recycled paper.

First Priority Rather Than Last

The future of recycling depends largely on the willingness of public officials to create new, long-term programs in the face of current pressures to build incinerators. Recycling is sometimes seen as a competitor of incineration because it can reduce the amount of waste that plant operators are paid to receive. Many communities guarantee incinerator operators a minimum volume of trash. But while recycling can eliminate high-quality fuel like paper and cardboard, it also removes unburnable glass and metal and reduces the amount of slag that forms from melted glass on the sides of furnaces. Slag and contaminated ash are such major problems that some incinerators have facilities on site that remove glass and metal from garbage before it is burned.

Yet some recycling advocates believe that attempts to see the two alternatives as complementary undermine the importance of reducing and reusing waste. "Too often recycling is seen as part of a happy marriage with incineration, rather than a primary solution," says Thomas Webster, research associate at the Center for the Biology of Natural Systems in New York. Webster has worked with biologist Barry Commoner on a pilot recycling program for East Hampton on Long Island designed to deal with about 70 percent of the trash—an amount comparable to incineration. Webster believes recycling could reduce trash even more if legislators set standards for packaging design, targeted plastic milk jugs and other items for deposit fees, and introduced "waste-initiator" taxes on packaging that can't be recycled.

"Reduction and recycling of waste should be first priority rather than last priority," says Webster. He considers incinerators a needlessly complex and expensive form of waste disposal—and a problematic one. The plants produce emissions believed to be harmful as well as toxic ash that must be landfilled.

"What we need to do is to get rid of the garbage, not just move it through one more machine," maintains Webster. "To get high levels of recycling you have to work hard. You need legislative strategies, and you need political will. But once you have the systems in place, you've solved the problem." □

PHOTOS: SUPPLIED BY JOHN R. PURVES

Medical Muddles, Technology's Crystal Ball, and Mysteries of the Mind

Solving Medicine's Moral Muddles

Hard Choices
by B.D. Colen
G.P. Putnam's Sons, $18.95

Life Choices
by Howard Levine
Simon and Schuster, $17.95

Reviewed by Arthur L. Caplan

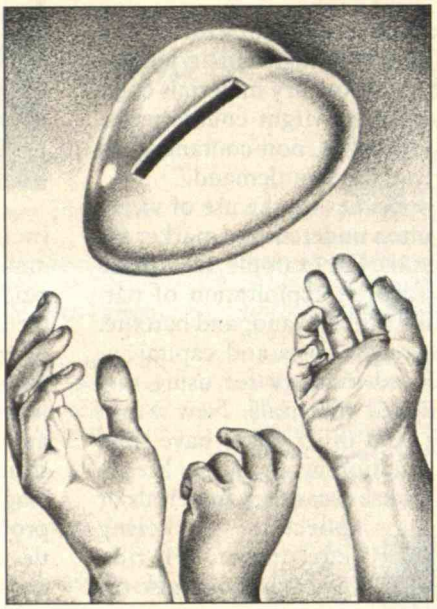
The social effects of new technologies are always more complicated than they initially appear to be. Finding an emerging technology that does not have both positive and negative implications for human welfare is virtually impossible. This moral ambiguity is particularly pervasive in medical technology.

Americans fear medical technology. We fear the Frankensteinian shadow cast by the ability to transplant both natural and artificial organs. Yet we are outraged when young children do not have access to liver transplants because of an inability to pay the costs.

We worry that medical technology will evolve a life of its own, forcing itself into the most elemental areas of human existence: procreation, birth, death. Yet we love medical technology—the bigger the better, the more complicated the better, the more the better. Hospitals compete to see who can have the first CAT scanner, NMR device, or PET scanner. Patients seek care at medical centers depicted as being at the forefront of research on transplants, artificial organs, cardiac surgery, or neonatal intensive care—even if they themselves do not require these services.

In medicine, more also means more expensive. With the bill for a liver transplant falling in the neighborhood of $150,000, an artificial-heart transplant costing around $275,000, and the tab for renal dialysis exceeding $2 billion for 1986, it is plain that success in using technology to cure human ills has its price and that price is high.

But money is not the only problem. There are other dilemmas raised by the advent of modern medical technology. As the authors of the books under review recognize, even if money were not an issue, our society would still have to grapple with a host of difficult ethical questions regarding the uses of medical technologies.



In fact, it is ethical uncertainty rather than fiscal despair that makes medical technology the object of attention by bioethicists, the media, and congressional committees.

Forging a Consensus

In *Hard Choices,* B.D. Colen, science editor of *Newsday,* focuses on making us aware of the moral muddles successful medical technology has provoked. Colen, who writes clearly and with passion, shows how the theme of technology as ethically ambiguous ought to be pursued in print. He exhibits an admirable facility for listening to and observing those in contact with medical technology—as either patients or health-care providers.

New medical technology, as Colen ably shows using vignettes drawn from the experiences of various families, is Janus-like. Machines that can extend life can also extend it beyond any meaning or significance. Technologies that can rescue babies who once would have certainly died are also used to rescue those who certainly should have been permitted to die. Diagnostic techniques that can detect terrible genetic defects before a child is born can also reveal minor problems such as the presence of an extra Y chromosome or merely the gender of a fetus. Such information may lead some parents to abort a pregnancy on highly dubious moral grounds.

Colen's book provides a rich portrait of families and patients struggling to cope with advanced medical technologies. The pregnant women he interviewed were grateful for the information that an ultrasound exam or amniocentesis had provided. But they were also burdened with the need to make decisions about continuing their pregnancies that an earlier generation of mothers did not have to face.

Colen offers few personal opinions or words of advice about these case studies. But in pursuing a few examples in careful detail, he manages to flesh out the ethical ambiguities inherent in many medical technologies in a manner both accurate and sensitive to the experience of doctors and patients.

In *Life Choices,* Howard Levine is concerned with helping the layperson work through some of the moral issues Colen identifies. But his attempt to provide a cram course in moral thinking does not prove very successful.

Levine, a philosopher who was the director of the National Science Foundation's Public Understanding of Science Program, begins with a rather desultory chapter on "bioethical thinking." He then takes the reader on a wearying voyage through more than 50 cases intended to highlight ethical problems and possible modes of analyzing them. The problem with this approach is that many of the cases are, indeed, dilemmas. The neophyte bioethicist is left with little more than a headache and a sinking feeling that the choices posed by medical success are so difficult that no definitive moral answers can ever be found.

What are we to say when confronted with the need to choose among potential kidney-transplant recipients who include a 50-year-old physical chemist with two young sons, a recent graduate of journalism school, an adolescent boy just entering high school, and a young mother on welfare who is the sole support for her family of five children? While we might bandy about the consequences of adhering to a particular moral theory in grappling with such a problem, as Levine suggests, the fact remains that no obvious answer can be found because such scenarios are not the product of ignorant or confused ethical thinking. They are grounded in real moral dilemmas.

Such hard cases in bioethics create a deceptive confusion. Not every moral problem in medicine is a dilemma. Contrary to the impression given by Levine, there has been enormous progress in ethical think-

ILLUSTRATIONS: JOHN O'SULLIVAN

New procedures help us make difficult ethical decisions in medicine.

ing about medical technology that has yielded many areas of consensus.

Only 30 years ago physicians argued that patients did not want accurate information about their diagnoses or therapy. And if it were provided it would only scare patients out of their wits. Since then Americans have made it plain that they want physicians to tell them the truth no matter how dismal it may be. They have made it clear that paternalism and benevolence are not an appropriate foundation for physician-patient interactions. Patients want doctors to obtain their consent for research and therapy, to treat them as participants in the direction of their care, and to leave them the final authority over administering medical technology. Patients, health-care providers, and the legal community have reached a consensus that patient autonomy must take precedence over the benevolent goals of the medical community when these two values conflict.

There are plenty of moral topics related to medical technology that are still the subject of enormous debate. What level of efficacy is adequate for baptizing a new technology as therapy? Who should decide when to terminate care when the patient is incapable of doing so? What kind of research, if any, should be permitted on subjects incapable of giving their own consent such as young children, demented people, fetuses, or even animals?

Yet even these vexing questions have given rise to procedures that help ensure that better rather than worse ethical answers will be found. Institutional review boards, hospital ethics committees, proxy consent mechanisms, state commissions on bioethics, and the newly formed congressional Bioethics Review Board are but a few of the bureaucratic constructs that help society cope with moral problems in medicine. While far from perfect, such procedural responses do constitute a form of social consensus about how to live with technological progress. And they are not sufficiently in evidence in Levine's book.

Despite these shortcomings, both books attempt to build bridges to allow more individuals to cope with the hard choices presented by medical technologies. We ought fervently to hope that they and other volumes will succeed in that attempt.

ARTHUR L. CAPLAN is director of the Center for Biomedical Ethics at the University of Minnesota.

Examining Technology's Crystal Ball

Tradeoffs: Imperatives of Choice in a High-Tech World
By Edward Wenk
Johns Hopkins University Press, $19.95

Reviewed by Daniel Grossman

A recent exhibit at the American Museum of Natural History in New York featured cave paintings created between 10,000 and 35,000 years ago. The intricate stone and bone carvings of birds, animals, and insects showed remarkable attention to detail. Apparently the onset of the Upper Paleolithic Era in Western Europe marked a cultural watershed—the time when musical instruments, jewelry, decorated burial sites, and carvings and paintings first appeared. The delicate beauty of these artifacts proves that the triumph of paleolithic humans was their ability to express themselves symbolically and artistically.

Today, convinced that humans are mainly tool-making animals, we tend to neglect these other roles played by technology. In *Tradeoffs: Imperatives of Choice in a High-Tech World,* Edward Wenk adopts just this limited perspective when he asks what has gone wrong with our technology and suggests how to change it. He notes that while technology is designed to serve, everywhere we turn there is evidence of insubordination. Leaking plants that make chemical fertilizers—gifts of the Green Revolution—kill and maim thousands. Malfunctioning nuclear power plants contaminate the food supply. Rockets blow up rather than lifting off to deploy their payloads in space. Obviously something is awry.

Wenk focuses on problems with the "technological delivery system"—the process by which scientific discoveries are transformed into products. Between the push of scientific and technological developments and the pull of the market, nobody is at the wheel steering around unexpected and dangerous obstacles. Scientists are too concerned with the quest for knowledge to foresee the effects of their discoveries. Industry, tamed by the professional manager, aims for short-term stability at the expense of long-term vitality. Finally, the public, "more sharply conditioned by [its] beliefs than by reason," is too volatile to know what it wants, much less plan ahead.

Wenk tries to uncover mechanisms for providing the foresight that society so sorely lacks. Because the federal government is a major player in this process, technological choices are rightly questions of public policy, he says. He recommends a structured fantasizing, asking "what if" questions for each option. Society ought to consider not only "can we do something" and "ought we to do it?" but increasingly "can we manage it?" and "can we afford it?" He believes that if the unintended results of technology could be anticipated, the political process would ensure that it would be put to the best uses. Equipped with up-to-date information and guided by ethical considerations, trade-offs among technological alternatives could be publically adjudicated.

Yet Wenk simply advocates making use of "technology-assessment" procedures already in service for over a decade. The president—the "nation's system manager"—relies on a panoply of tools to navigate through dangerous technological shoals, including the science advisor and the Office of Science and Technology Policy. Congress leans on the Congressional Research Service, the General Accounting Office, and the Office of Technology Assessment for analyses. Wenk admits that despite the availability of information from these bodies, neither Congress nor the executive branch has avoided "the pathology of the short run" because politicians always focus on immediate problems. Nowhere in *Tradeoffs* does

Technological artifacts reflect the culture that spawns them.

Wenk explain how even the best information on the effects of technology will improve the planning process: the unresponsive institutions he decries are left untouched by his solutions.

Public Input into R&D

Only his belief that the public must be more involved offers hope. Toward this end, he recommends improving public education, making computerized databases on the effects of technologies available at public libraries, and requiring public officials to release more accurate information on the trade-offs embodied in any piece of legislation.

But beyond admonishing citizens to "share their insights on particular issues or decision processes with elected officials," Wenk fails to indicate how to enhance democratic participation in the process of choosing technologies. His unwillingness to embrace bona fide democratic reforms, such as citizen control of technology from development to marketing, is clearly shown by his timid proposal to grant the public control over a mere one-half of one percent of the federal R&D budget. He expects that such an experimental citizens' advisory body would suggest different research priorities than the elite peer-review process now in place. Although, as Wenk says, "it would be fascinating to see what research a citizen body would actually recommend," enacting this modest proposal would surely not democratize science.

More fundamentally, Wenk's search for "side effects" of technological choices is misguided. His program is destined to fail because even if we had the fortitude and ability to look ahead, the questions he recommends are the wrong ones to ask. He does not recognize that our artifacts are not just means to ends; they are integral parts of life and reflect the culture that spawns them. They also structure social and political relationships within the culture in ways often totally unrelated to their ostensible "function."

The car, for instance, is more than a mode of transportation. It is a symbol of power and a member of the family. If Henry Ford had had the foresight and desire to "assess" the possible outcomes of his technology, would he have predicted modern Los Angeles? Would he have foreseen that we would risk nuclear war to keep Mideast oil flowing into gas tanks and threaten our Alaskan wilderness in search of new deposits? If we merely sought means of locomotion, we would have followed the advice of philosopher Ivan Illich and opted for bicycles.

If the ancient artisans can teach us any lesson, it is that our "tools" embody many social qualities—spiritual, political, and artistic as well as practical. Focusing on one of these aspects to the exclusion of others—failing to understand our technological culture—leads to false and simplistic conclusions about how to strive for a better world.

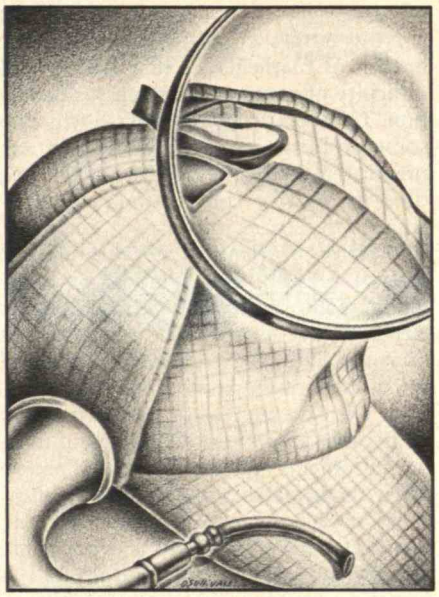
DANIEL GROSSMAN is a doctoral candidate in political science at M.I.T. studying decision making in science policy.

To err is human. It is also rational.

Cognitive Science Meets Sherlock Holmes

Minimal Rationality
by Christopher Cherniak
M.I.T. Press, $19.95

Reviewed by John Rubin



The question "what does it mean to be rational?" has been tormenting philosophers and psychologists for a good long time. Complexity theory, in contrast—the study of the speed of computer programs—is a new discipline of seemingly parochial interest to mathematicians. It comes as a surprise, then, to read the argument of philosopher Christopher Cherniak that the results of complexity theory set limits on human rationality. Any such connection would be of immediate interest to cognitive scientists and practitioners of artificial intelligence, who rely on computational models to study the mind.

Cherniak's view of cognition can be illustrated by way of a Sherlock Holmes story (one that Cherniak himself uses for a different purpose). The antagonist of the story has hidden an important photograph somewhere in a room. Holmes directs Watson to throw a smoke bomb in the room. The ploy works: the adversary betrays the location of the photograph in the mistaken belief that there is a fire.

Holmes's strategy illustrates a reasoning mind at work. Beginning with a goal (to find the photograph), Holmes somehow comes up with a hypothesis about how to achieve it (deploying a smoke bomb will cause the bad guy to reveal the location of the photograph). The next step is for Holmes to use his legendary smarts to decide whether his smoke bomb hypothesis is true or false. That is, will the plan work?

Cherniak considers the possibility that people test such hypotheses in a formal fashion. We can imagine the hypothesis somehow encoded in the language of logic (represented in Holmes's brain as a pattern of neural firings). Holmes decides whether a hypothesis is true or false by proving it—or its negation. In other words, Holmes must try to deduce the hypothesis as a theorem using the rules of logic and the

collection of things he already knows as axioms.

Now enters complexity theory, the branch of mathematics that assesses the difficulty of computations such as deduction. Complexity theory has shown that some problems cannot be solved by any practical computer because the memory or time needed for computation would be enormous. For example, says Cherniak, "To prove theorems [in a part of number theory] of only 617 symbols or fewer would require a network with so many . . . elements that, even if each were the size of a proton . . ., the machine would exceed the volume of the known universe."

So what's a mind to do? What if one of its hypotheses happens to be one of these hard problems? Cherniak says that people often confront such a "finitary predicament": we have only so much time and memory to make decisions. It's fine to look before you leap, but to stand around in catatonic indecision is another matter.

According to Cherniak, since the formal route of verifying hypotheses can take eons, people are forced to use heuristics, or rules of thumb. These rules are quick so that minds never get hung up on hard problems, but they are also dirty and sometimes lead to mistakes. It all comes down to a cost-benefit analysis. We accept occasional reasoning errors to avoid the computational intractability of logic. To err is human, and it is also rational from this point of view.

Cherniak's rationalization of errors in human reasoning comes during a research boom on the subject. Amos Tversky of Stanford and Daniel Kahneman at Berkeley, among others, have uncovered a host of common reasoning foibles. The following personality sketch helps provide an example:

> "Bill is 34 years old. He is intelligent, but unimaginative, compulsive, and generally lifeless. In school, he was strong in mathematics but weak in social studies and humanities."

Subjects in Tversky and Kahneman's experiment were asked to judge which was more likely: that Bill plays jazz for a hobby, or that Bill is an accountant who plays jazz for a hobby. A great majority of people take the second choice, but the correct answer is the first. (Every accountant who is a jazzman is also a jazzman pure and simple.) The reasoning shortcut that leads to this error is called "the representativeness heuristic." Bill's personality is more representative, or typical, of an accountant than of a jazz musician.

Although the representativeness heuristic isn't perfect, it usually does lead to correct answers. For example, suppose you find an unfamiliar bright-colored, sweet-tasting object in the produce section of the supermarket. It's a good bet that the object is some kind of fruit, and the representativeness heuristic would lead to just that conclusion. In this respect, the heuristic can be considered rational.

Yet Cherniak's ambition—to demonstrate a deep link between two hot areas of research, the psychological study of such reasoning biases and the mathematical study of algorithms—proves unsuccessful for a number of reasons.

The "finitary predicament" is not new to the philosophy of mind. Philosopher Daniel Dennett has discussed the same issues, arguing that people's need to make quick decisions in a fast-paced world puts a premium on cognitive efficiency. In "Cognitive Wheels," he writes that the demand for an efficient system of information storage is in part a space limitation . . . but more importantly it is a time limitation." Not only is Dennett aware of the finitary predicament, he also discusses foibles in human plan making that result.

Cherniak's introduction of complexity theory fails to add clout to Dennett's argument. His examples of computationally intractable problems seem purely academic: he needs to give examples of biologically important problems whose solutions complexity theory has shown to be out of practical reach.

More important, the focus of *Minimal Rationality* misses the most interesting facet of cognition. In Cherniak's view, thinking involves a stage at which a hypothesis (later to be tested) is somehow generated. This is a big "somehow." Cherniak acknowledges that it is essential to pose the right question in the first place, but he offers no substantive suggestions for how that might be done. This is unfortunate, since the origin of hypotheses seems more mysterious than their proof or refutation. It is more important to ask how Holmes came up with the idea of a smoke bomb as opposed to a hunch, say, that clarinet practice in an adjoining room would do the trick. Harder problems for cognitive science lie here—in trying to understand the origin of ideas.

JOHN RUBIN recently received his Ph.D. in cognitive science at M.I.T. and is now writing for public television.

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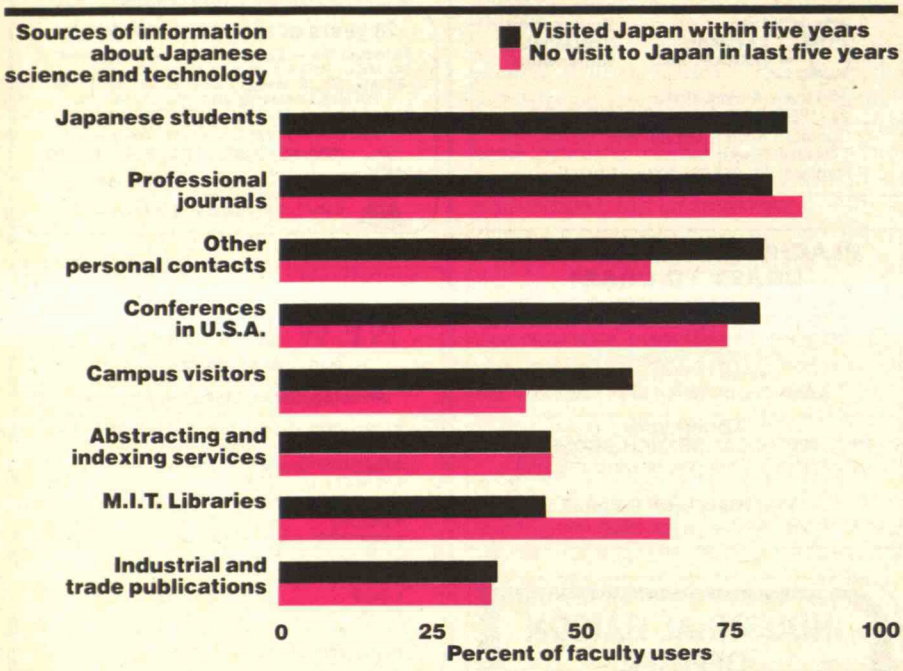

M.I.T. faculty who have visited Japan put a high value on information about Japanese science and technology. And these travelers use sources different from those tapped by their stay-at-home colleagues.

Learning about Japan

M.I.T. has within it "one of the most comprehensive sources" of information about Japanese science and technology that exists in the United States outside the federal government, says Richard J. Samuels, associate professor of political science who heads the M.I.T.-Japan Science and Technology Program.

In a 1986 survey, Samuels and Professor Eleanor Westney of the Sloan School of Management discovered that more than half of the science and engineering faculty at M.I.T. had been to Japan in the previous five years. And "there is a striking 'Japan effect'—a strong positive correlation between those who have been to Japan and those who highly value and frequently use Japanese scientific and technical information," Samuels told an international conference on Japanese information exchange at the University of Warwick, England, early this fall.

This suggests that personal relationships with Japanese colleagues are perhaps the most effective medium of communication we have, providing "an extraordinary wealth" of ideas and documents. But one problem remains: "A mechanism to systematically harvest the reports and working papers that these specialists acquire" is urgently needed—at M.I.T. and in the nation as a whole.

Video on Japan

The M.I.T.-Japan Science and Technology Program, whose first emphasis is to help M.I.T. students learn about Japan (*see above*), has taken on a more formidable related assignment: helping all Americans understand how to do business with a people whose organizations and culture are so different from ours.

Coordinator Patricia E. Gercik is at work on an interactive computer teaching program that would provide "a knowledge base for people doing business with the Japanese." Her goal is an expert system with rules for conducting successful negotiations with the Japanese, and she hopes to have it ready within two years for use on personal computers.

Refusing Political Grants

M.I.T. joined 42 other members of the Association of American Universities late last spring in pledging to refuse pork barrel federal grants made without traditional evaluations of scientific merit.

The pledge opposes so-called earmarked grants—funding proposals that are introduced directly into Congress without peer review. The *New York Times* says at least $137 million was awarded in "earmarked" grants in 1985, up from $3 million in 1982. John M. Deutch, M.I.T. provost, calls the trend a "catastrophe" because it represents a substitution of political power for technical merit in the award process.

No Crisis in Natural Gas

Low-cost gas is far more abundant worldwide than most estimates have indicated, says a new report of the M.I.T. Energy Laboratory. Today's plentiful supplies and low prices will probably continue for several decades, even if government policies that artificially raise prices and reduce demand are repealed.

These policies, adopted by many governments during the "energy crisis," limit the uses of natural gas and set minimum prices for it. Those regulations should be eliminated, says the Energy Laboratory: they cause higher-cost fuels to be used in place of gas, resulting in "an overall economic loss for society."

Energy Laboratory analysts say that North American gas prices appear to be lower than the cost to producers of replacing reserves, so supply should decrease or prices gradually increase here during the next two decades. But no critical shortage is forecast. In Western Europe and the Pacific "the gas surplus is alive and well," say the analysts.

Soviet Computer Culture

A new emphasis on the use of personal computers in the Soviet Union has come with the openness of the Gorbachev era.

Articles about computers in Soviet popular science magazines between 1970 and 1983—the Brezhnev era—focused on use by collectives. Authors stressed multi-user computers and networks, with the question of integrating computers into society "largely ignored," writes M.I.T. student Matthew C. Wiener in the thesis for his bachelor's degree awarded last June.

When Gorbachev came to power in 1983 there appeared suddenly "a new conception of how computers can be most effectively used," Wiener says. The emphasis in popular science magazines changed to personal computers, with articles designed "to teach large numbers of

CHART: TOM BRIGGS DESIGN

people" how to program them, writes Wiener. He concludes that the government is trying "to create a 'computer culture' in the Soviet Union."

Wiener, who speaks Russian and has studied in Leningrad, has drawn his conclusions chiefly from analyzing two Soviet magazines—*Nauka i Zhizn'* (*Science and Life*), with 3.5 million circulation, and *Priroda* (*Nature*), published by the Academy of Science for about 50,000 influential Soviet citizens.

Alcator Corrected

We at the Plasma Fusion Center were surprised to learn from the "Reporter" for July (*page 79*) that the goal of Alcator C-MOD, M.I.T.'s new high-field tokamak now under construction, will be "to achieve the first ignited—or self-sustaining—plasma." All of this for $17.5 million! C-MOD will use deuterium or hydrogen fuel, *not* the deuterium-tritium fuel mixture that would produce intense self-heating of the plasma by alpha particles (helium nuclei) created in the fusion process. Alcator C-MOD will simulate (in deuterium plasma) conditions and transport phenomena approaching those in an ignited, high-field tokamak; however, the performance level of Alcator C-MOD, as measured by plasma temperature and the quality of confinement, will likely be about a factor of two lower than that required for ignition (*if* the plasma were a deuterium-tritium mixture).

In its FY88 budget submission to Congress, the U.S. Department of Energy has requested funds to begin construction of a high-field ignition tokamak called the Compact Ignition Tokamak (CIT). The CIT design builds extensively on the data base and engineering experience acquired in the highly successful Alcator series of experiments, as well as engineering concepts developed at M.I.T. The CIT would be a national research facility located at the Princeton Plasma Physics Laboratory; its total estimated cost is approximately $350 million, and initial operation could begin as early as 1993.

In 1983 Alcator C achieved (in deuterium plasma) the necessary density and confinement conditions, *not* temperature conditions, required for "energy-breakeven" (*if* the plasma were a deuterium-tritium mixture).

RONALD C. DAVIDSON,
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